DESIGN

FOR

INDUSTRIAL ARTS

METAL-WORK

JOHN KYLE

HON. A.R.C.A. LONDON

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DESIGN

FOR

INDUSTRIAL ARTS

JOHN KYLE
Hon. A.R.C.A., London

BOOK II---METAL-WORK

Authorized by the Department of Education for British Columbia

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"Life without Industry is Guilt,
And Industry without Art is Brutality."

—*Ruskin.*

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DESIGN FOR INDUSTRIAL ARTS

BOOK I.—WOODWORK.

BOOK II.—METAL-WORK.

BOOK III.—LETTERING, BLOCK PRINTING, ETC.

CONTENTS.

DESIGN

FOR

STUDENTS OF INDUSTRIAL ARTS

WITH

APPLICATION TO METAL-WORK.

GENERAL PREFACE.

IN the light of present-day educational philosophy the subject of industrial arts has assumed a broader aspect than ever before. Creative thought and motor activities have been brought into close relationship; aesthetic and constructive problems are correlated with each other and the educational worth of industrial arts has been increased, enriched and dignified.

"I believe profoundly", writes J. Howard Whitehouse, Headmaster of Bembridge School, England, "that manual activities—using these words in their widest sense to embrace art and craftsmanship—should not be regarded as trivial 'extras' or as pastimes for young children, but should be given a place of honour in every school, and should be recognized as definite instruments of noble education.

Such an ideal has always been in front of us here and so far as we have been enabled in any degree to realize it, this has been without loss to the ordinary academic work common to all public schools. We believe, indeed, that the latter has

greatly benefited owing to the larger vision, the keener intellectual spirit introduced into the school by a wider curriculum giving to arts and crafts their proper place."

Attention to thoughtful creative skill in design with due regard to the aesthetic element in constructive work opens up a great vista to the student. To all his creative efforts he may bring a thought content embracing history, geography and scientific study.

The subject of industrial arts includes the history of the human race, and the adaptability of man to his environment; it shows the development of the tools and processes of present-day industries.

In every age and in every country the lives of the people have been guided by principles and the same may be found underlying their constructive efforts. A knowledge of the fundamental principles of design forms the basis of all phases of worthy industrial arts and to make this clear to the student this grammar of design has been written.

Professor R. A. Kissack of New York University, in an article in the Industrial Arts Magazine, March, 1927, refers to the fact that no furniture of American manufacture was found at the Exposition of Industrial and Decorative Arts at Paris, because only modern exhibits of original design were permitted. While American manu-

facturers were busy making copies of furniture from Jacobean, Elizabethan, Chippendale, Hepplewhite, Adams and other historic styles, they were neglecting to design furniture from fundamental principles, furniture appropriate to the homes and to the lives of Americans.

This fault is not confined to the people of any one country, but each, building on a knowledge of the fundamental principles of design, should foster an expression of their own individuality and national characteristics. The rules of design as contained in this book will give the young craftsman in any country a basis on which to build any creative and industrial activity.

The rules are few in number, clearly stated, frequently repeated, and their uniform consistency emphasized in many materials.

"Rules", says Robert Henri, "are only for mechanics," but the rules of industrial design here drawn up are for artisans and craftsmen who wish to develop into robust art lovers. The rules are flexible enough to prevent mechanical and primitive production.

"The arranging or designing part in all kinds of work must be a delightful exercise of skill to all who know the rules," writes Mr. W. R. Lethaby, one of the foremost art craftsmen in the world to-day. The best players are those who know and obey rules. Through knowledge, man is enabled to triumph over brute labour and

produce beauty. Beauty is thus the expression of man's pleasure in labour.

The problems, both correct and incorrect, have nearly all been culled from work done in Junior High Schools and therefore the practicability of the lessons is assured.

The author desires to acknowledge the whole-hearted encouragement and support of several technical instructors in formulating this text-book of Design, and wishes to thank Mr. John MacLean, Mr. A. Wishart, Mr. W. J. Williams, and Mr. Harry Jones, for their readiness in providing drawings, photographs, and examples of their students' work.

INTRODUCTION TO METAL-WORK.

"By Hammer and Hand All Things Do Stand."

THE art of metal-working was well developed many ages ago: books dealing with the subject date back as far as the 12th century, and examples of work are very much older, as might be expected. "The technique can be learnt in thirty seconds but it takes years to become a good craftsman", says Nelson Dawson, one of the foremost metal-workers in Europe. Without doubt the beginning is easy but the possibilities and scope for development are immense.

The technique of art metal-work embraces soldering, welding, riveting, and shaping; hardening, annealing and tempering. It requires a knowledge of the action of acids and resistants, of fluxes and solders, and a first-hand acquaintance with copper and brass. Thus it is that the student is introduced to a wonderful range of tools, materials and processes, and for this reason alone, art metal-work may well be termed an important educational subject.

The student should also be taught what character in design means and for what appropriate-

ness in ornament stands. He should be shown that in good metal-work decoration, the material rules the forms of which the decoration is composed; that when metal forms and contours have to be embossed these should be designed with due regard to what can reasonably be accomplished with a hammer, tracer and punches. Forms that are very difficult to make should be avoided, as the effect obtained is not commensurate with the labour involved.

In designing for metal-work the same subdivision described in designing for woodwork should be kept clearly in mind.

Directions for spacing, proportioning, contours and surface enrichment all hold good in both materials. The guiding principles are also similar, and for this reason the sixteen rules at the commencement of this metal-work section are reprinted.

The metal may be worked on lead, wood or pitch, but a clean and convenient way for school work is to pounce the metal on soft wood. Tools required for a beginner are simple and copper of from 22 to 26 gauge will be found suitable for school projects.

Designs are drawn or traced on the metal and then beaten out by means of a hammer and various punches from the back of the metal. As a rule steel and brass tracers and punches are used but sometimes for high relief and very wide surfaces

and bosses, wooden tools are used. Tracers and punches can be made easily from old screw-drivers, chisels, nails and other odds and ends usually found around a workshop.

After the metal has been fixed face downwards on a wooden block or on a pitch block the outline of the design should be traced with a liner or tracer-punch by the aid of a repousse hammer.

The next step is to take the metal off the block and turn it over in order to beat the spaces between the outlines. When this has been completed turn the metal over again and finish the necessary surface work. Constant hammering of this kind hardens the metal and makes it brittle. It then requires annealing and this consists in heating the metal to redness after which it is slowly cooled. It may be necessary to anneal the metal several times before the work is completed. When the decoration is finished the metal should be cut to shape and fixed to the foundation by screws, pins, rivets or solder, and then it should be polished and lacquered or otherwise finished.

A Grammar of Design.

RULE

I. An oblong should have a proportion of subtle dimensions which is difficult for the eye to detect.

II. In dividing a horizontal primary mass into two horizontal subdivisions, one of the spaces should dominate the other in a correct ratio.

III. In dividing a horizontal primary mass into three horizontal subdivisions, one of the spaces should dominate the other two in an artistic ratio.

IV. In dividing a horizontal primary mass into two vertical subdivisions, the spaces should be equal in area and similar in form.

V. In dividing a horizontal primary mass into three vertical subdivisions, the dominant space should be in the centre and the spaces at each side should be equal in area and similar in form.

VI. In dividing a horizontal primary mass into more than three vertical subdivisions, the spaces should be equal in area and similar in form, or arranged in groups.

VII. In dividing a vertical primary mass into two or three horizontal subdivisions, one of the spaces should dominate the other in a correct ratio.

VIII. In dividing a vertical primary mass into more than three horizontal subdivisions, the spacing should be varied in an agreeable ratio and the wider space should be the lowest.

IX. In dividing a vertical primary mass into two vertical subdivisions, the spaces should be equal in area and similar in form.

X. In dividing a vertical primary mass into three vertical subdivisions, the dominant space should be in the centre and those at each side should be equal in area and similar in form.

XI. In dividing a vertical primary mass into more than three vertical subdivisions, the spaces should be equal in area and similar in form or arranged in groups.

XII. When a secondary mass is added to a primary it must correspond in form and character in order to ensure harmony.

XIII. For outlines and contours the elliptical or oval curves of beauty which are more subtle, refined and artistic than the circular, should be used.

XIV. The border should have a correct proportion in relation to the panel. Decorations should be made by the repetition of varying forms to prevent monotony.

XV. The panel should have correct proportions,and may be decorated by radiating lines and varying forms which should emphasize and harmonize with the shape of the panel.

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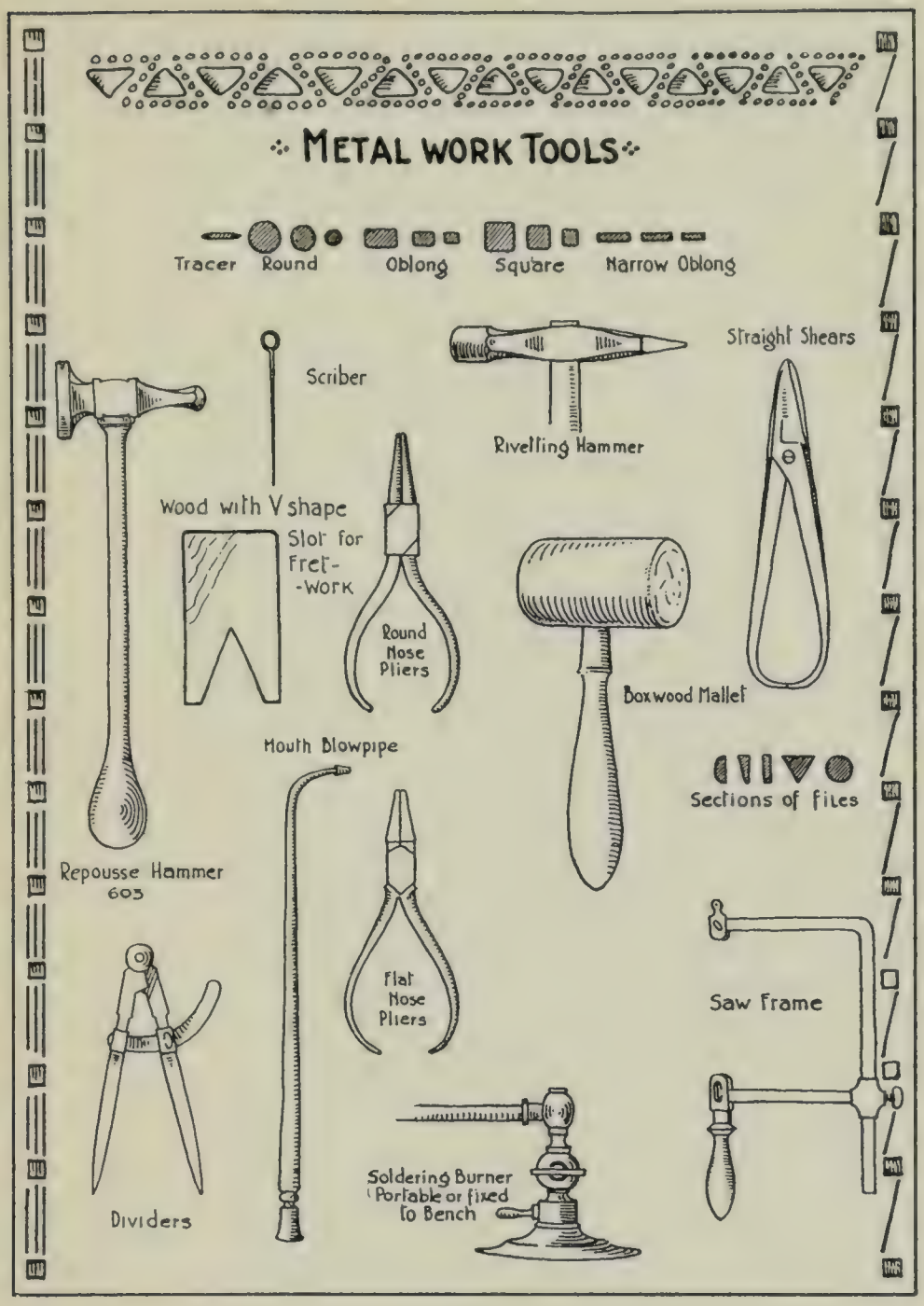
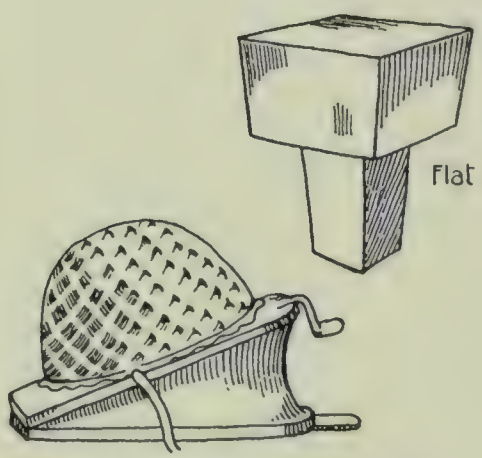
XVI. The shape of the profile or section of a moulding should be the key form used to build up the ornamentation of the moulding.

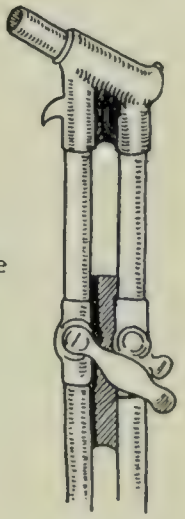
Of these sixteen rules it will be found that Rules I, II, VII, XIII, XV and XVI are particularly applicable to Metal-work.


METAL WORK TOOLS
Tracer
Round
Oblong
Square
Narrow Oblong
Scriber
Wood with V shape
Slot for Fret-work
Round Nose Pliers
Riveting Hammer
Straight Shears
Boxwood Mallet
Mouth Blowpipe
Sections of Files
Repousse Hammer
603
Flat Nose Pliers
Saw Frame
Dividers
Soldering Burner
Portable or fixed to Bench

METAL WORK TOOLS

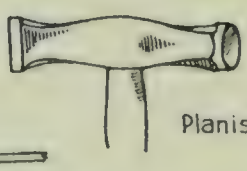


Flat stake

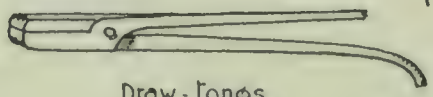


Blow pipe

Bellows



Planishing Hammer



Draw-tongs

METAL ETCHING.

AN appropriate type of metal-work for school projects is etching. The design is first transferred to the metal and then the background or the ornament is carefully painted over with asphaltum varnish.

When the asphaltum is dry the plate is dipped into a solution of nitric acid—one part nitric to five parts water. The exposed part of the metal will be eaten by the acid. When the design has been etched to the required depth wash the plate under running water and remove the asphaltum with benzine or gasoline. The metal should then be rubbed with emery cloth and finished with beeswax and a soft cloth.

Benzine should be used to dilute the asphaltum if that is necessary. If per-chloride of iron is obtainable it will be found to be superior to nitric acid.

Lessons similar to those illustrated on page 17 will give beginners some excellent experiences with metal. In carrying out these projects the students will be called upon to cut, file, drill, rivet, etch and polish.

The initial plates on page 17 were etched in brass while the watch-fobs were etched in copper. The paper knives or envelope openers have etched pieces riveted to the handle.

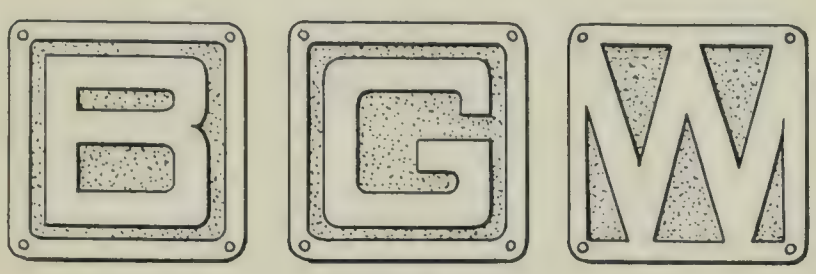
The test-tube flower-holder, page 18, is a neat project for beginners and gives an opportunity to apply knowledge of correct contours. These are all projects which have been completed successfully by students in Junior High Schools in Vancouver, B.C.

In designing ornamentations to be applied either by embossing or by etching, the principles of radiation and variety should be thoroughly understood. Examples A, D, F and H, on page 19, are all characterized by an absence of this knowledge and they, therefore, show shapeless forms with no radiating lines.

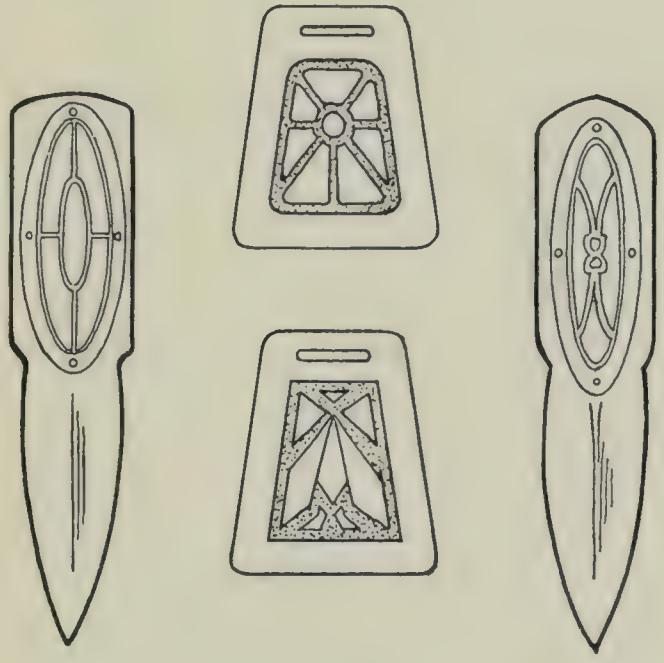
The improvement on examples C, E, G and I will, at once, be apparent. All the design forms can be made with a simple lining tool, a round-nosed punch and a repousse hammer, or they could be successfully painted and etched. It may be noticed that the curved lines are elliptical and form the boundary lines of agreeable mass-forms.

Examples A, B and C, page 19, show the improvement of a design which at A lacks the principles referred to and also has very poor arrangement. Greater cohesion in the design is gained in B by taking the line right round the

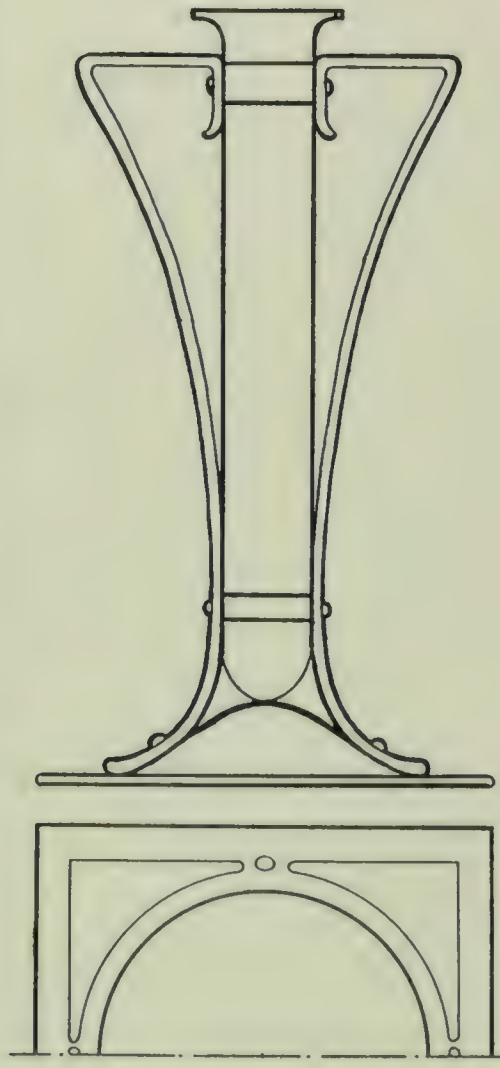
ETCHED METALWORK



Initial Plates

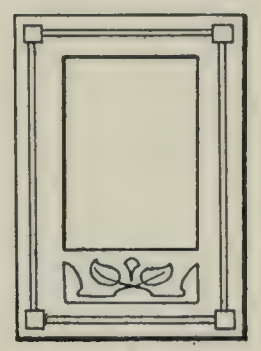


METAL WORK



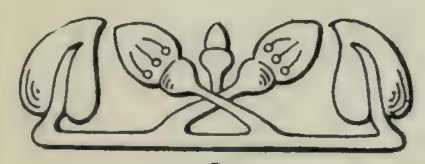
METALWORK
EMBOSSING

A.

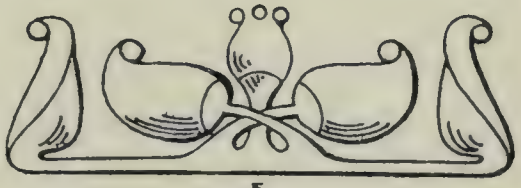


B.

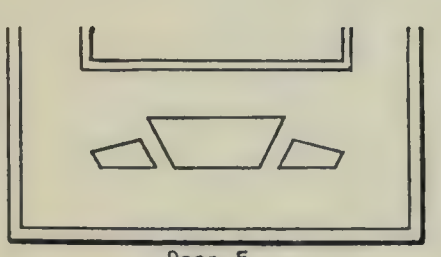
C.



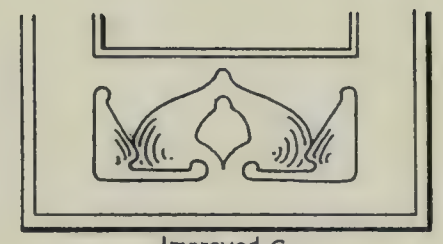
D.



E.



Poor F



Improved G.

Poor H.

Improved I

frame to form a border. Example C, however, shows more thought and knowledge of principles than either A or B.

The first essential in making a frame is to decide on the correct proportion of the complete oblong. In obedience to rule I the oblong should have a proportion of subtle dimensions which is difficult for the eye to detect. The ornamentation of the frame should harmonize with its shape and the lines of the design should emphasize the shape of the frame—as stated in Rule XV:—"The panel should have correct proportions and may be decorated by radiating lines and varying forms which should emphasize and harmonize with the shape of the panel."

On page 23 may be seen at A and B the similarity of forms which may be made on wood with a woodworking tool and on metal with a metal-working tool. The small bosses at B which are easily made with a round punch in metal would show a sparkle which would increase the effectiveness of the design.

In planning a design for any metal object the very simplest primary mass which can be made, and one that need not cost the designer a single thought, is the regular square as at C, or the regular circle at E, page 23.

When, however, the shape has to be transformed into an oblong as at D, or an ellipse as at F, fine judgment is required to come to a satisfactory

decision regarding the correct length. Hence the importance of the knowledge of the "Golden Ratio" as well as Rule XIII:—"For outlines and contours the elliptical or oval curves of beauty should be used which are more subtle, refined and artistic than are the circular".

The surface enrichments, it will be observed, are entirely composed of lines and bosses in the making of which very few tools are required.

On page 24 projects may be seen, made by children of elementary school age who have been taught principles of design. The objects are simple in effect but very pleasing.

The design principles which govern artistic metal-work are exactly the same as those laid down for artistic woodwork. The principles of proportion applicable to the one are also appropriate to the other; for instance, Rule I:—"An oblong should have a proportion of subtle dimensions which is difficult for the eye to detect." The same may be said with certain reservations about the decorative motifs. Those suitable for first year woodwork, where the features are made with the V tool and punch, are very similar to the metal-work features which have to be made with the tracer, punch and embossing hammer. Those decorative motifs for both wood and metal should be composed of simple masses contrasting with radiating lines wherever possible.

The successful designer is always familiar with

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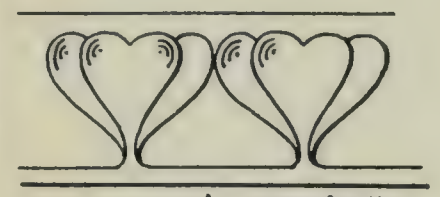
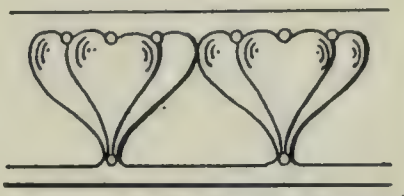
the use of the tools at his disposal and he is willing to be controlled and limited by those forms and shapes which these tools readily produce.

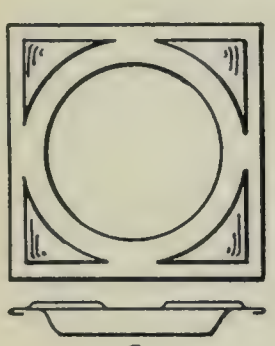
METAL WORK



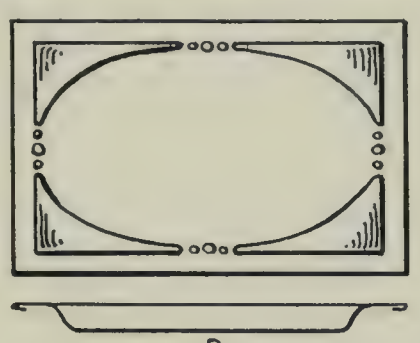
A Forms for the V tool (WOODWORKING)



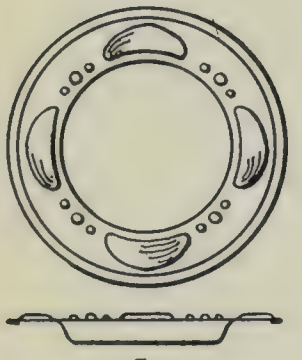
B. Forms for the metal tracer and punch.



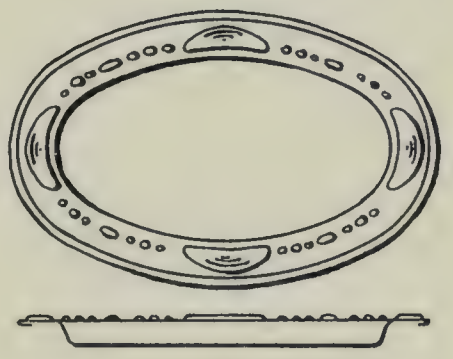
C.



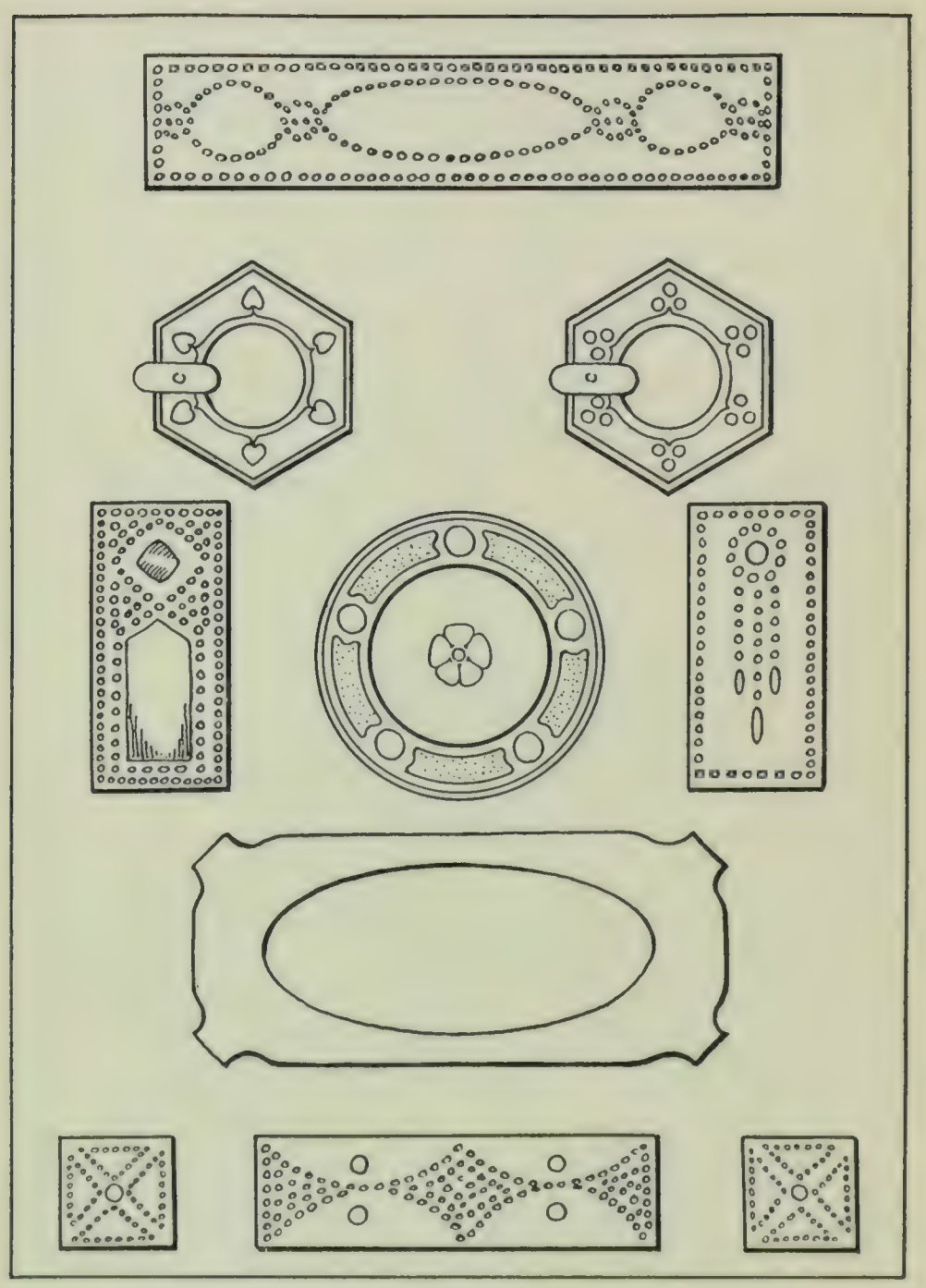
D.



E.



F.



ART METAL-WORK.

METAL has a fine, stable, and permanent appearance when finished into useful articles for the home or place of business. The nameplates of copper, brass handles and finger plates for doors, bell pushes, coal or wood boxes, mirror frames, and many more suitable projects all add richness and quality to the furnishings of a home. When they are artistically designed and well made they are worthy of admittance to both the simple houses of craftsmen and the most expensive residences. When they show evidence of having been made by a human being and not by a machine, so much the better, seeing that "art is the expression of man's pleasure in labour".

It may be observed that we have passed by a type of hand repousse made from thin material, thin copper, sheet brass or pewter. This is worked on felt or linoleum and the design is pushed up in bold relief from the back. It has an advantage in school of being a relatively silent craft; no pitch block, hammer or punches are required, and no annealing is necessary, but it is unsatisfactory from many points of view.

The pattern on thin metal is pressed out as though the material were leather and then it is nailed to wood. Thus a wooden article is made to look like one of metal, but the metal is too thin to be of any real service. This insincere type of craft should not be encouraged in an educational institution.

Contrary to this type of thin metal-work may be classed the robust-looking metal name-plate.

A copper or brass name-plate on a door or gate gives a stamp to the house. There is distinction attached to it, and if the name-plate is on the craftsman's own door he may receive regular thrills as he arrives home daily. As has been well stated by William Morris, the great craftsman:—"The pleasure which ought to go with the making of every piece of handicraft has for its basis the keen interest which every healthy man takes in healthy life and is compounded chiefly of three elements:—variety, hope of creation and the self-respect which comes of a sense of usefulness to which must be added that mysterious bodily pleasure which goes with deft exercise of bodily powers."

The excellent alphabet for embossing, on page 28, together with the numerals which will be found on page 29, have the recognized proportions of about two to three: that is, the width of each letter and number is two-thirds the height. The letters and numbers have a bossed appearance

and will be found to be particularly appropriate and effective on a name-plate. Moreover, the letters so designed will look equally well either worked by repousse or by etching.

In designing a name-plate the first important point is the proportion of the rectangle. It is here that the first rule of design should be remembered so that common proportions such as one by one and a half, one by two, or one by three, may be avoided and some subtle aesthetic proportion be selected.

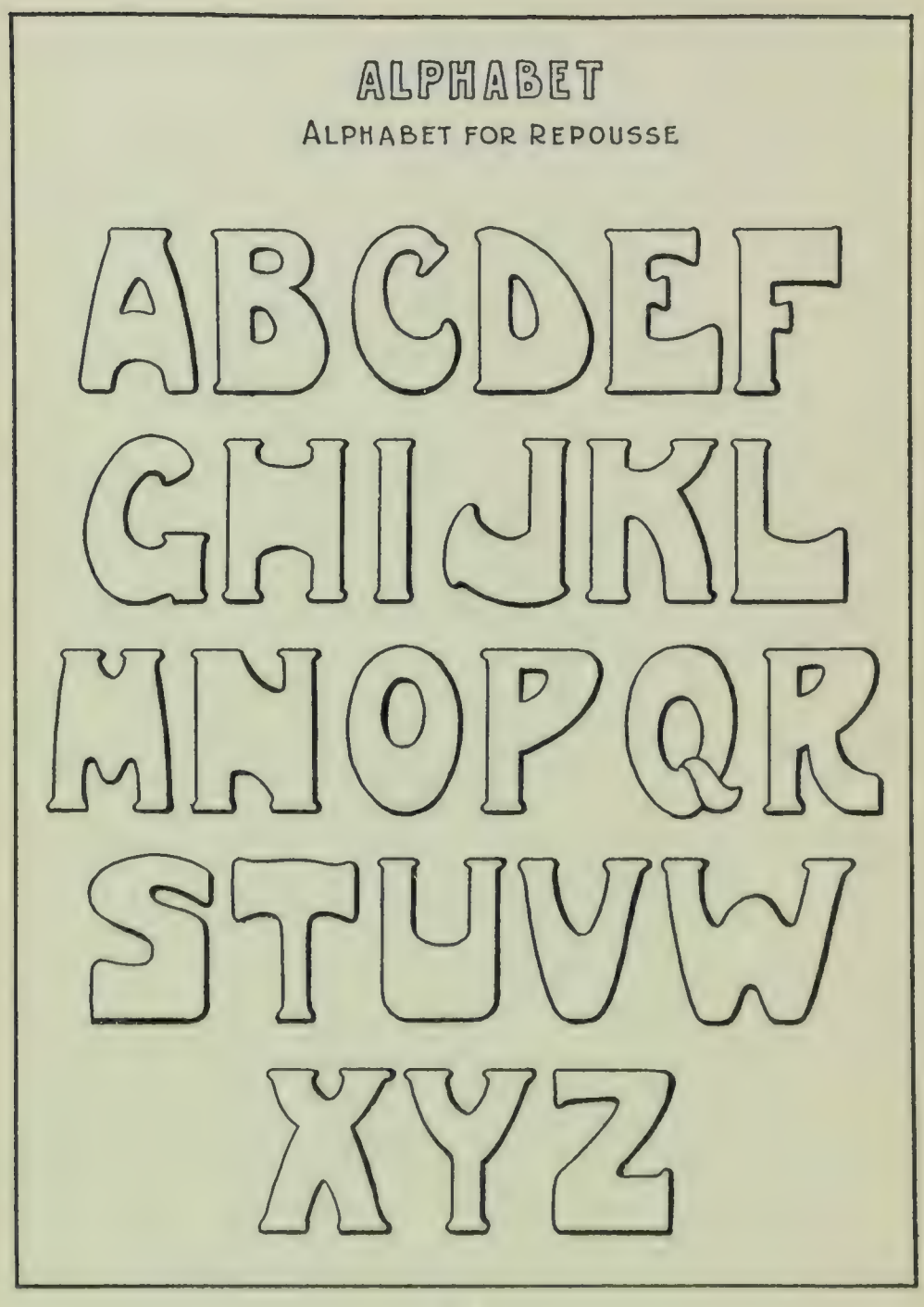
The contour of the edges also requires careful designing and then the letters may be drawn.

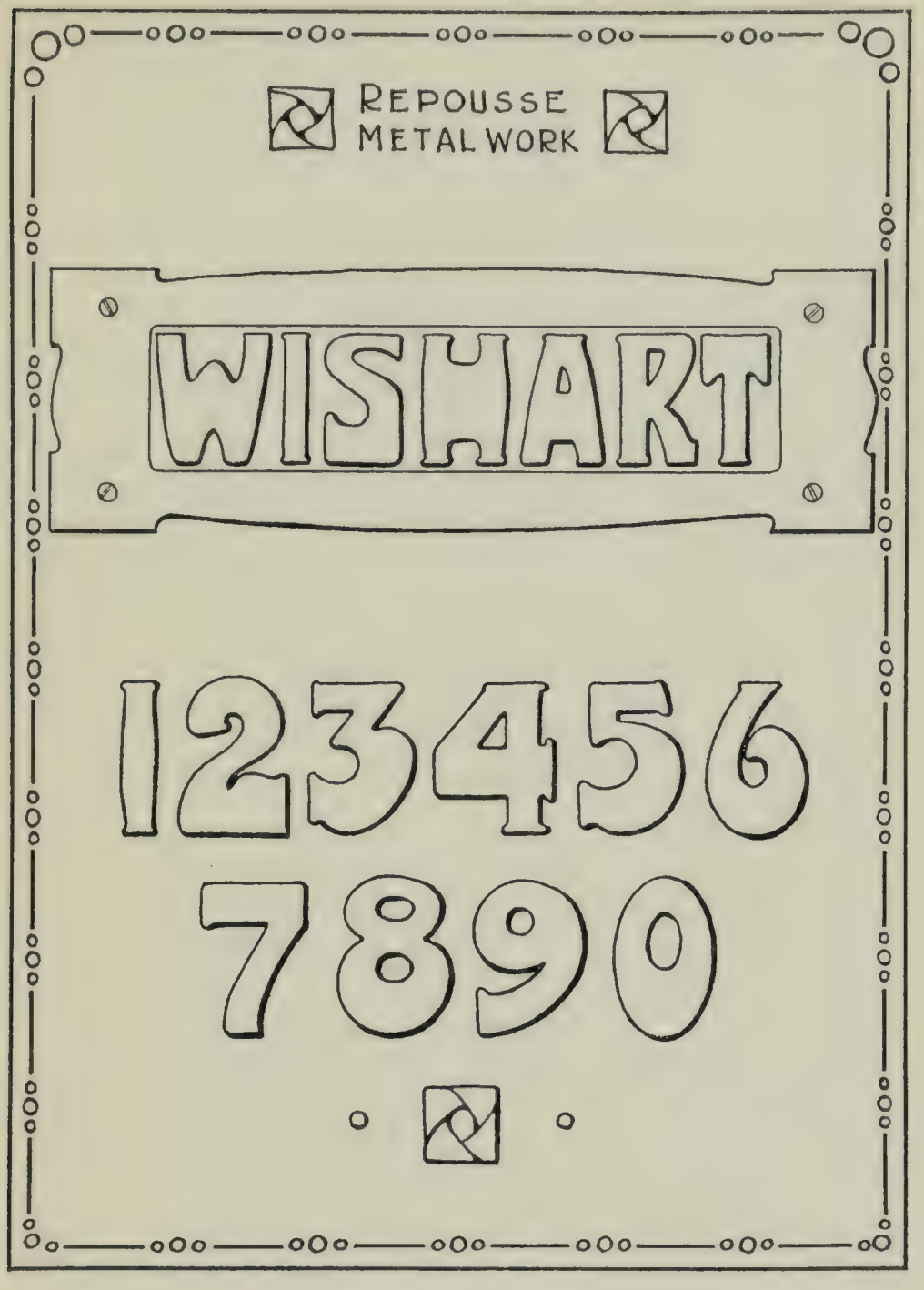
The contours of the letters and numbers are elliptical or oval in form and thus obedience to Rule XIII is displayed.

The vertical divisions will also be found to obey Rule VII, which is as follows:—"In dividing a vertical primary mass into two or three horizontal subdivisions one of the spaces should dominate the other in a correct ratio."

ALPHABET

ALPHABET FOR REPOUSSE




REPOUSSE
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METAL PIERCING.

PIERCING metal is resorted to in order to lighten the effect, but great care must be taken in so doing not to weaken the structure. The effect is often further enhanced by placing coloured material behind the metal fitting so that it can be seen through the piercings. Good results are also obtained from a combination of repousse and piercing; and even pierced overlays of different metals may be introduced.

Copper, brass, lead, pewter, aluminum and duralumin are good metals for overlaying, and the combination of metals gives excellent colour effects.

In making designs for pierced metal, one should realize that piercing draws attention to the contours. Therefore a working acquaintance with Rule XIII is indispensable, i.e., "For outlines and contours the elliptical or oval curves of beauty should be used which are more subtle, defined and artistic than the circular". Reference to pages 32 to 34 will show that the unity of each design is gained by using radiating lines, thus recognizing Rule XV:—The panel should

have correct proportion, and may be decorated by radiating lines and varying forms which should emphasize and harmonize with the shape of the panel".

The mind of the designer should thus dwell on elliptical and oval forms, and while the compass may be used to lay out the pattern, the curves should be drawn free-hand.

The archimedian drill stock will prove the best for drilling holes in order to thread the fret-saw preparatory to cutting. It is provided with balance weights which assist in making a smooth revolving action. A little water or a piece of tallow will serve as a lubricant for drilling.

All the designs shown on pages 33 and 34 would also be suitable for etching.

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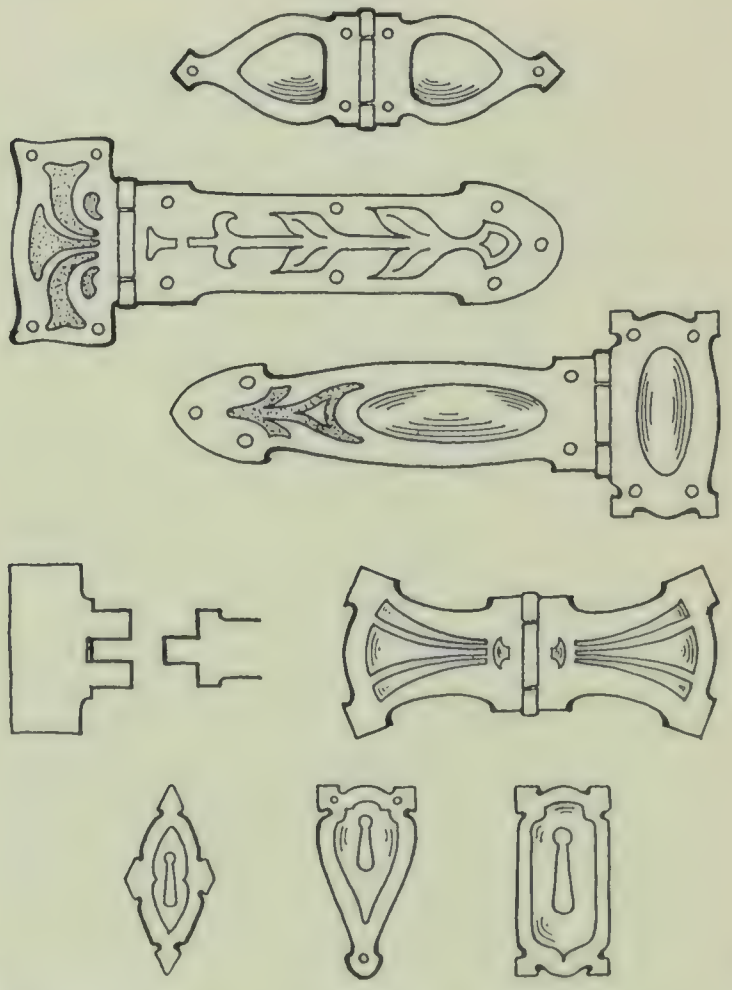
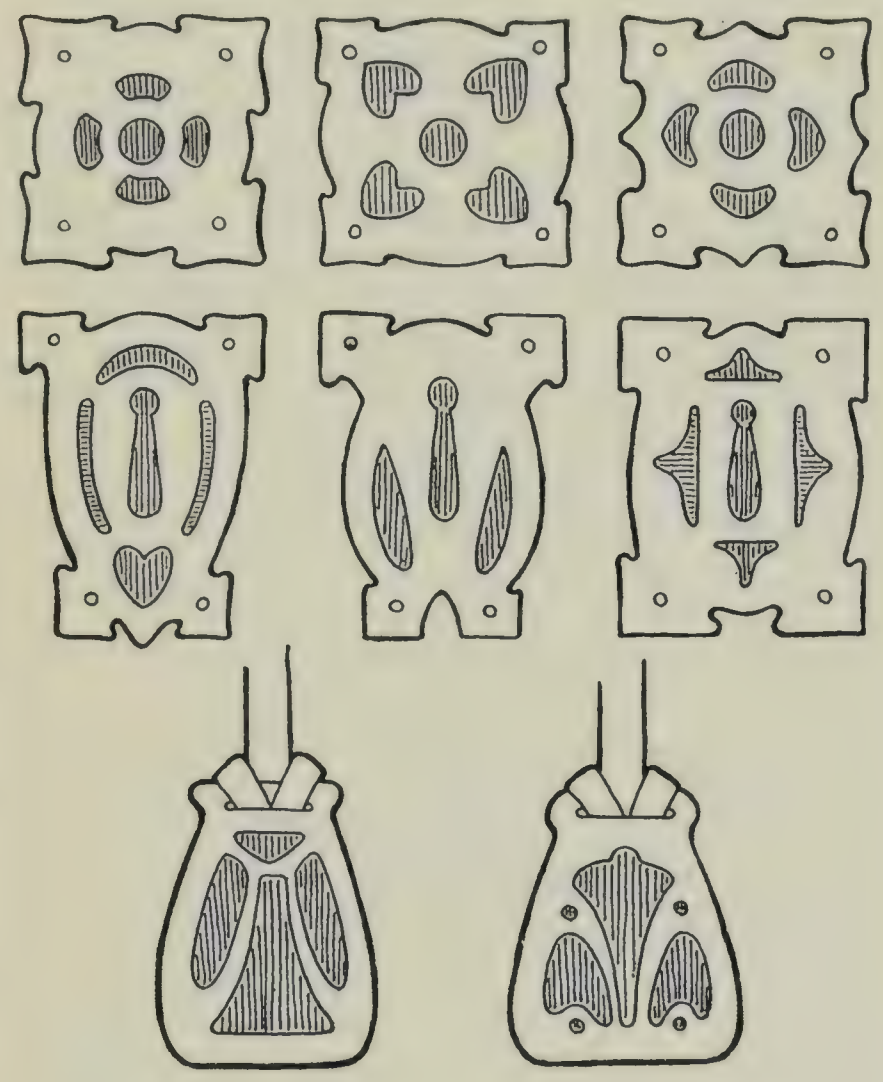
METALWORK
THE HINGE

Decorations by embossing and etching

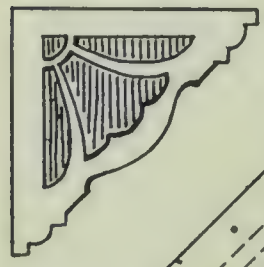


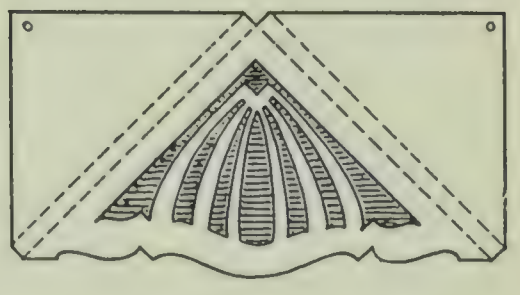
Metalwork
Piercing



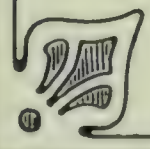
HINGE
ENDS

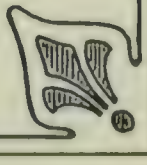
CORNERS
DECORATED BY PIERCING





Desk pad corners





FORGING.

IRON without Art has a stern and rather forbidding look, and yet it can be charmed by the Art Craftsman into beautiful forms which softens its severity. Iron stands for strength, simplicity and severity, Lethaby tells us, and on its sinister side, for cruelty and terror. In the old apportionment of the seven metals to the seven planets, iron belonged to Mars as gold to the Sun and silver to the Moon. The iron crown of Lombardy or the iron cross of Germany are instances in which the mere name of the metal lends a mysterious and moving import of invincible sternness.

Man, we are informed by the philosopher Hegel, should be prouder of having invented the hammer and nail than of having created masterpieces of imitation, meaning, of course, that the creative faculties are superior to the imitative. To discourage the use of the hand in the educational process is to close up the main avenue to the mind, so Dr. Ballard tells us, and robs the pupil of his one means of creative expression. "Every rise in the quality of the work men do is followed swiftly and inevitably by a rise in the quality of the men

who do it", writes Dr. L. P. Jacks, one of the greatest among philosophers to-day. Therefore, the course for the educator who presumes to influence character is clear and well defined, and an attempt to foster originality of conception embodied in design is imperative in all educational handicrafts.

In exercising the student's ability in this direction, and in using the stern wrought iron as the medium, the first essential is an appreciation of Rule XIII, which insists that subtle, refined, oval curves are preferable to curves of a circular nature. This is very clearly proven by reference to the work of the best Art periods.

Figures A, B and C on page 38 illustrate the evolution of a design for a simple bracket. The necessary supporting piece in all its primitive simplicity is seen at B, but structure and beauty combined will be found at C.

In the development of the small electric light stand seen at D, E, F, the harshness of the intersection made by the vertical and horizontal pieces is softened by the feature at G. This rosette is so bent that it harmonizes the two pieces which are fixed in opposite directions; and note that it does not try to imitate any natural flowers.

One of the most absurd things in metal-work is to see the wonderful efforts made to construct flower and plant forms. The labour on such pretentious productions is misspent, as it is always better to accept forms which come naturally to the

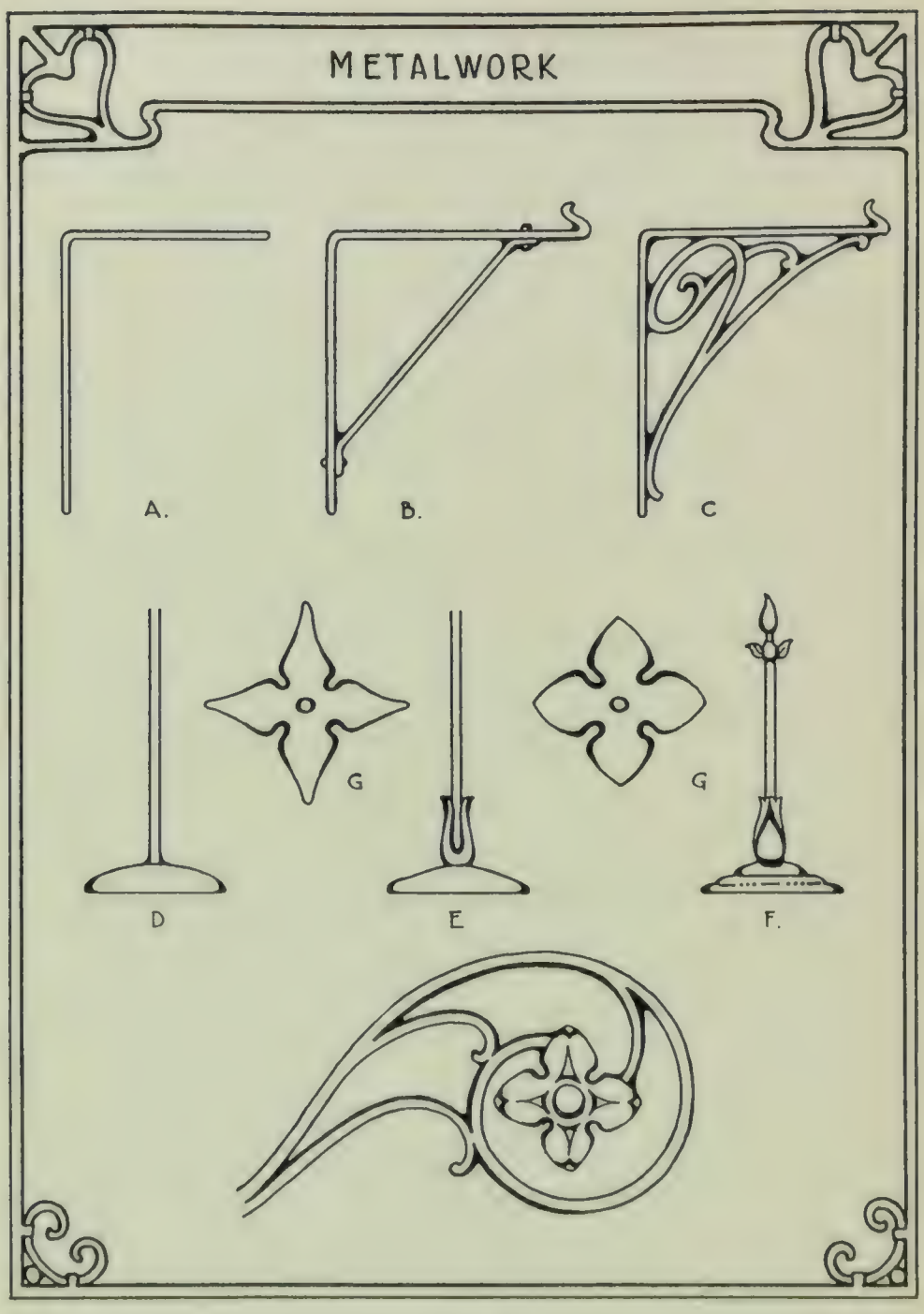
material. Rose petals and complicated leaf forms cannot be included in this category.

The projects on pages 39, 40, 41 and 42, were made by pupils at school in New Westminster, Victoria, and Vancouver, B.C., and the work bears evidence of sound training in design as well as an appreciation of the rules of the game: the curves are mainly elliptical, the proportions and spacings agreeable, and careful observation will show that the young craftsmen have not attempted to make forms which are not natural to wrought iron.

A successful design in wrought iron depends in a great measure on the beauty that comes from radiating lines. While this is very pronounced in metal, it is consistent throughout all designs.

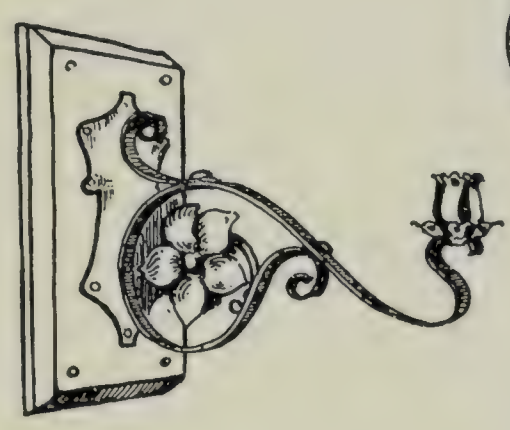
On page 39 observe the vertical divisions of the fern stand; see how the student has obeyed rule V, which is stated as follows:—"In dividing a horizontal primary mass into three vertical subdivisions, the dominant space should be in the centre and the spaces at each side should be equal in area and similar in form." The radiating lines of iron within the centre panel are simple, yet entirely successful.

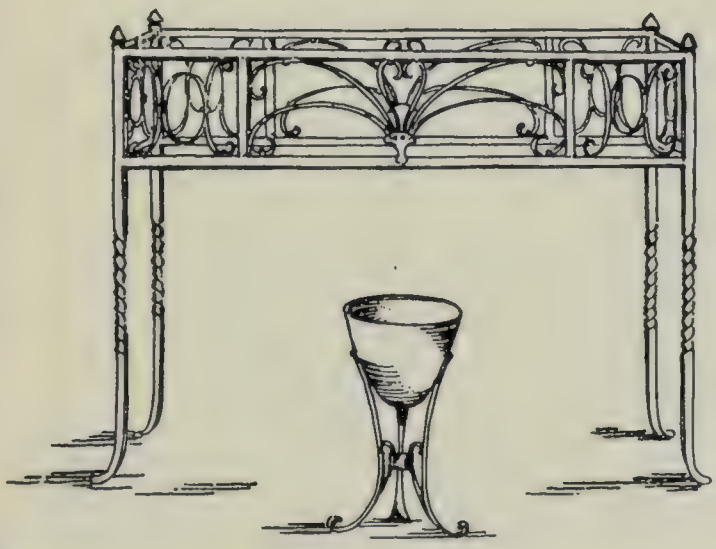
On page 40 the horizontal divisions of the lamp are satisfactory, and all the other objects on pages 41 and 42 are characteristically iron. The best example of all, however, is the gate on page 41. This shows intelligent planning and wise decisions. For students' work, it is excellent.

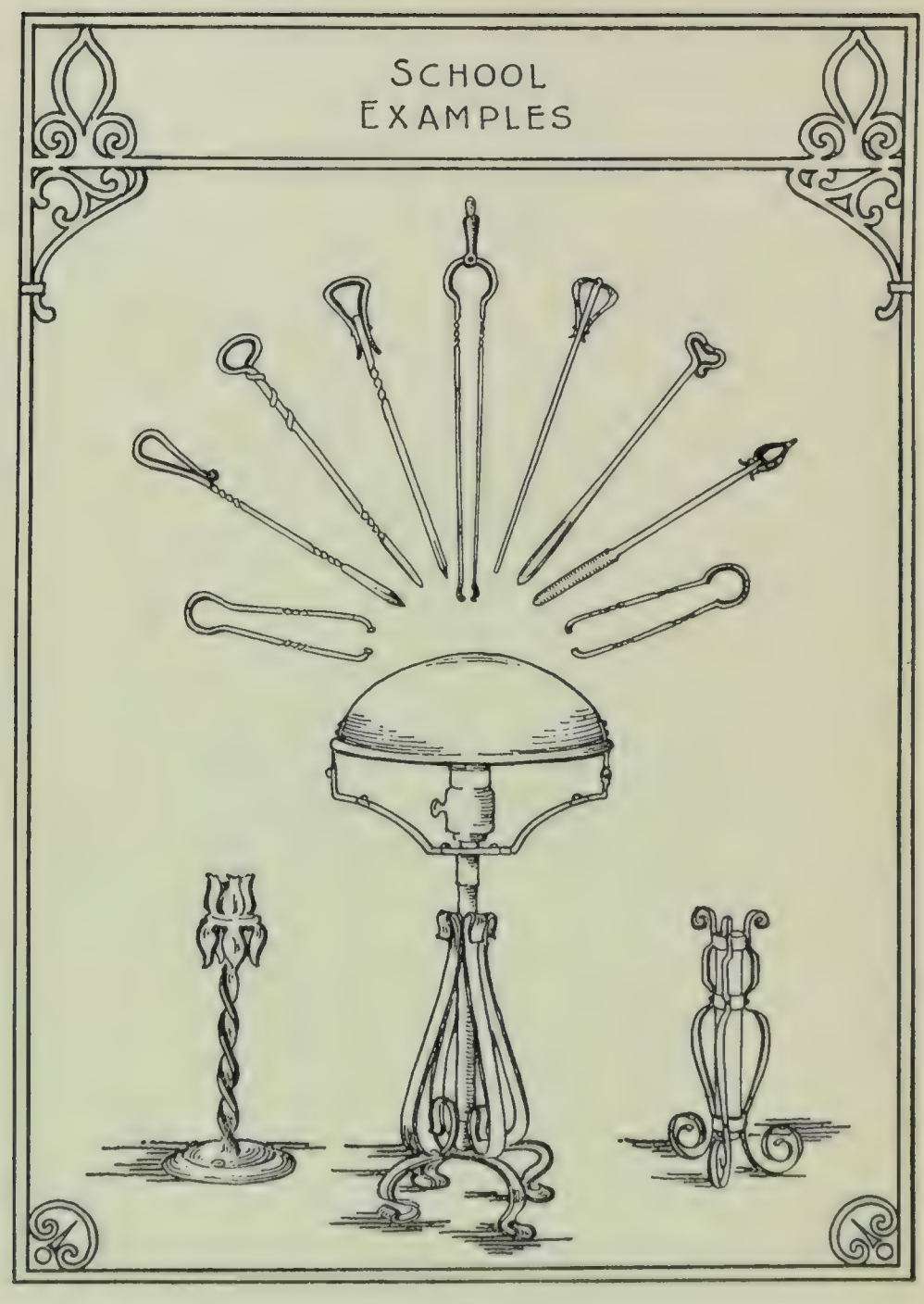

METALWORK
A.
B.
C
G
G
D
E
F.

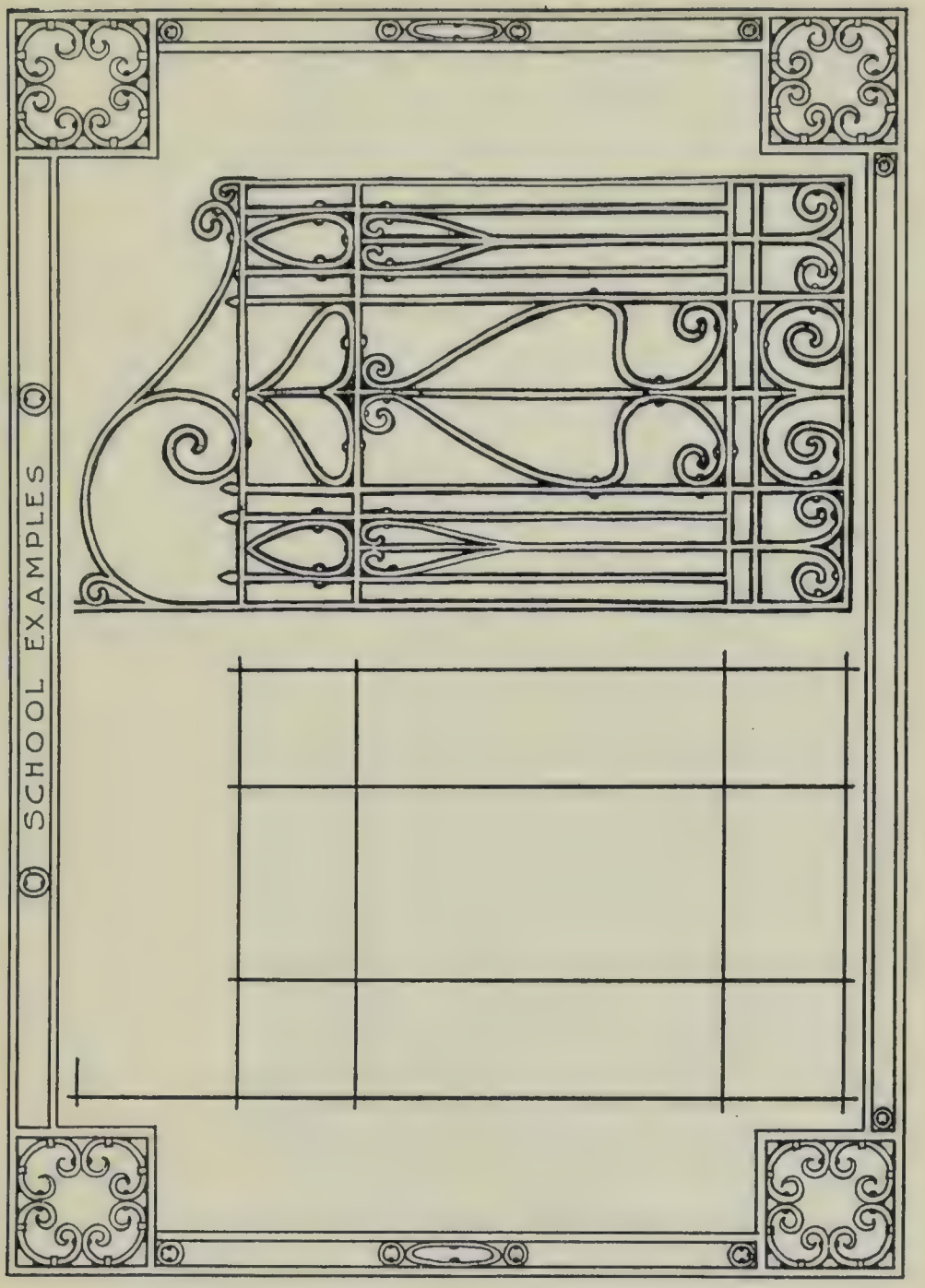
WROUGHT IRON

SCHOOL EXAMPLES






SCHOOL
EXAMPLES



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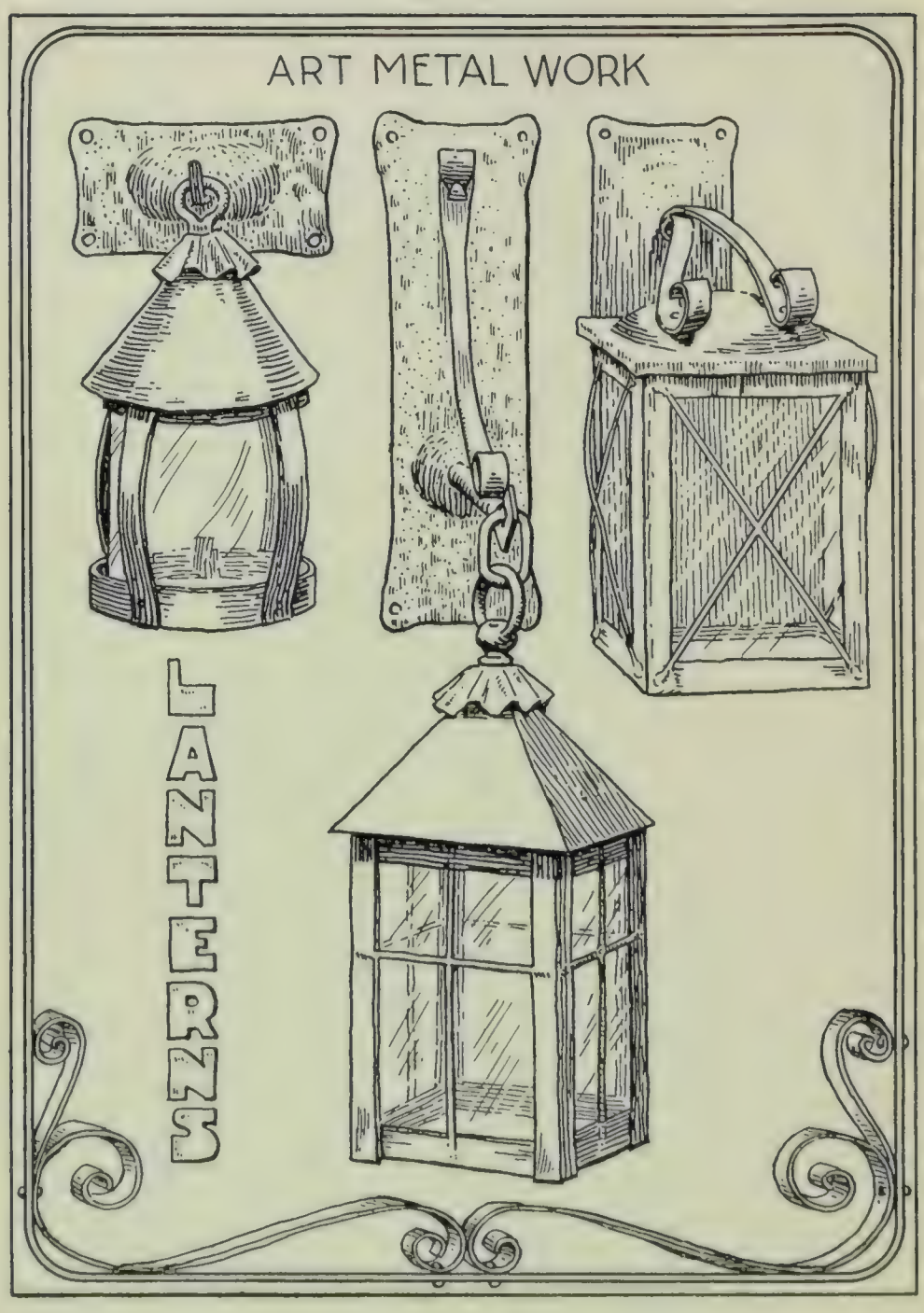

ART METAL WORK
MEDIUM

CONTOURS.

CONTOURS for metal forms which have to be raised by hand must be designed with due regard to what can be accomplished with a hammer and snarling iron. Forms which are difficult to make should be avoided; there is nothing to be gained by resorting to tricks in order to make unusual shapes, and there is beauty enough and to spare in the forms which come naturally and seem to belong to the metal.

In designing a pot the proportion of the enclosing oblong should be first decided and the height should be made in agreeable relationship to the width. The curvature should next be drawn, remembering that the widest part should not come half-way up the height but should be nearer either the top or bottom, as at 2 and 3, page 46

When the design has thus far succeeded and decoration is desirable, a simple band may be drawn. The placing of this band and the width thereof are decisions which must be carefully made; otherwise a wrong decision might ruin a good pot. It would be wrong to put the band

half-way up, just as it would be wrong to have the greatest width half-way up.

It would be well at this point to recapitulate Rule II, which states:—"In dividing a horizontal primary mass into two horizontal subdivisions one of the spaces should dominate the other in a correct ratio." Rule III will also be found to enter into the designs on page 47, for when the horizontal mass must be divided into three spaces one of these should dominate the other two in an artistic ratio.

In decorating the main form avoid over-elaboration and study rules laid down for guidance on the projects seen in pages 46, 47 and 48.

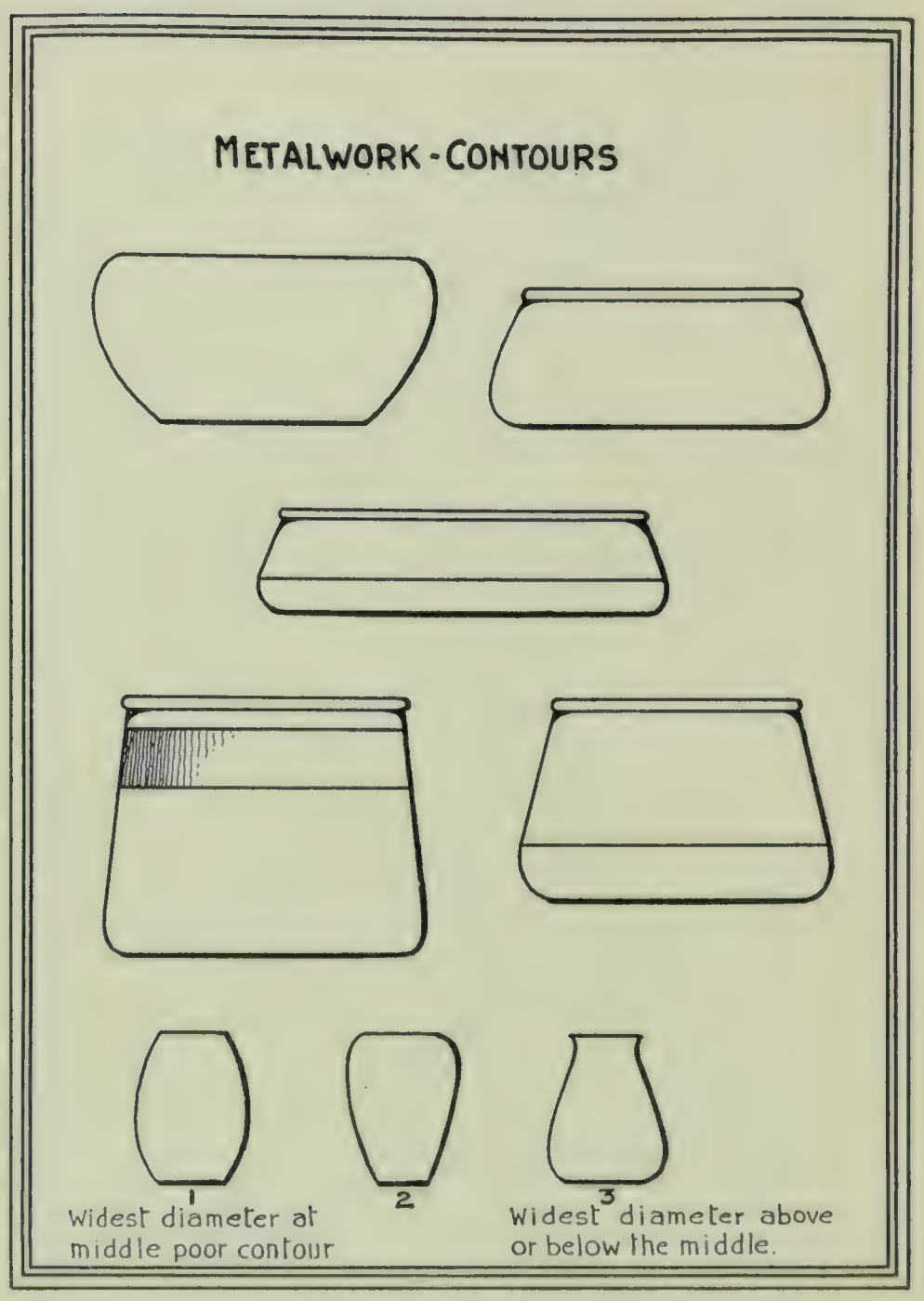
On page 47 will be found some shallow copper bowls. The band will be found in its correct place on examples B, C, D and E, which bears out Rule II, "In dividing a horizontal primary mass into two horizontal subdivisions one of the spaces should dominate the other in an artistic ratio."

The ornamentation on example A is too low down, as can easily be observed by comparing A with B or C.

On page 48 will be seen some proof of the Rule XVI, "The shape of the profile or section of a moulding should be the key form used to build up the ornamentation of the moulding."

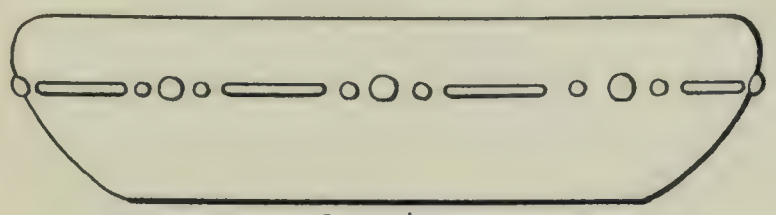
At E and F it will be observed that the surface is flat, and therefore straight-lined ornament is appropriate and in harmony. There are round

bosses introduced for variety and interest, but the main lines are straight. At G the heart shapes are formed by placing the section lines of the curved surface opposite to each other. This is on the same principle as the well-known egg and tongue decoration which was designed for the ovolo moulding. In like manner H and I are designed, each carrying out the same idea of using the line of the section to be the controlling line of the decoration. While G, H and I would look right on E and F, the reverse order would be objectionable because the straight lines would be distorted on the curved surface.

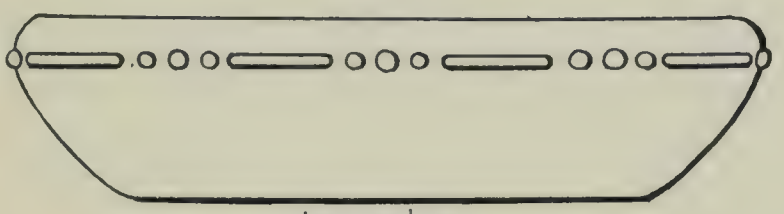

METALWORK - CONTOURS
1
2
3
Widest diameter at middle poor contour
Widest diameter above or below the middle.

DECORATING THE CURVED SURFACE

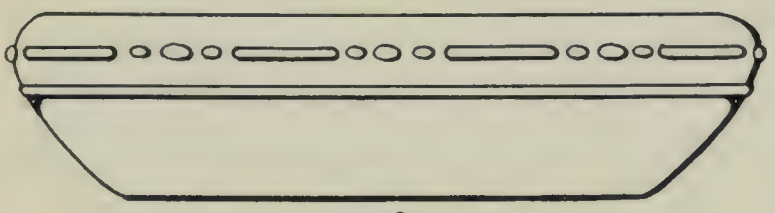
Horizontal spacing



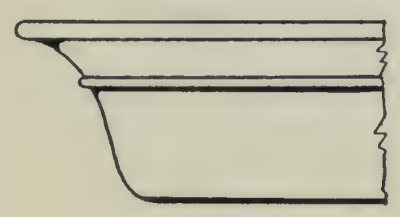
Poor (A)



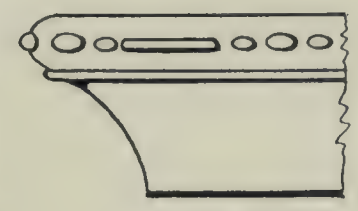
Improved (B)



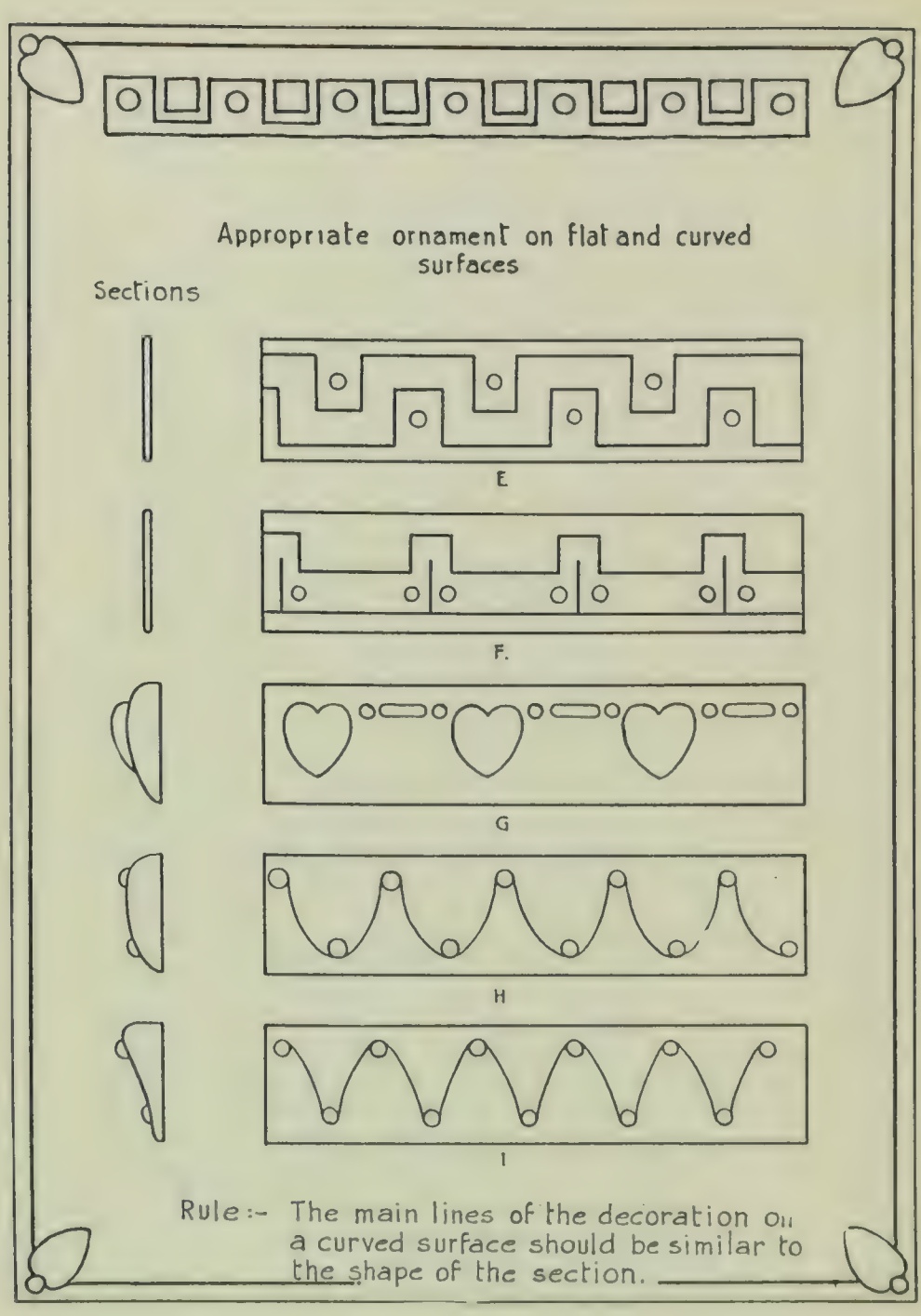
(C)



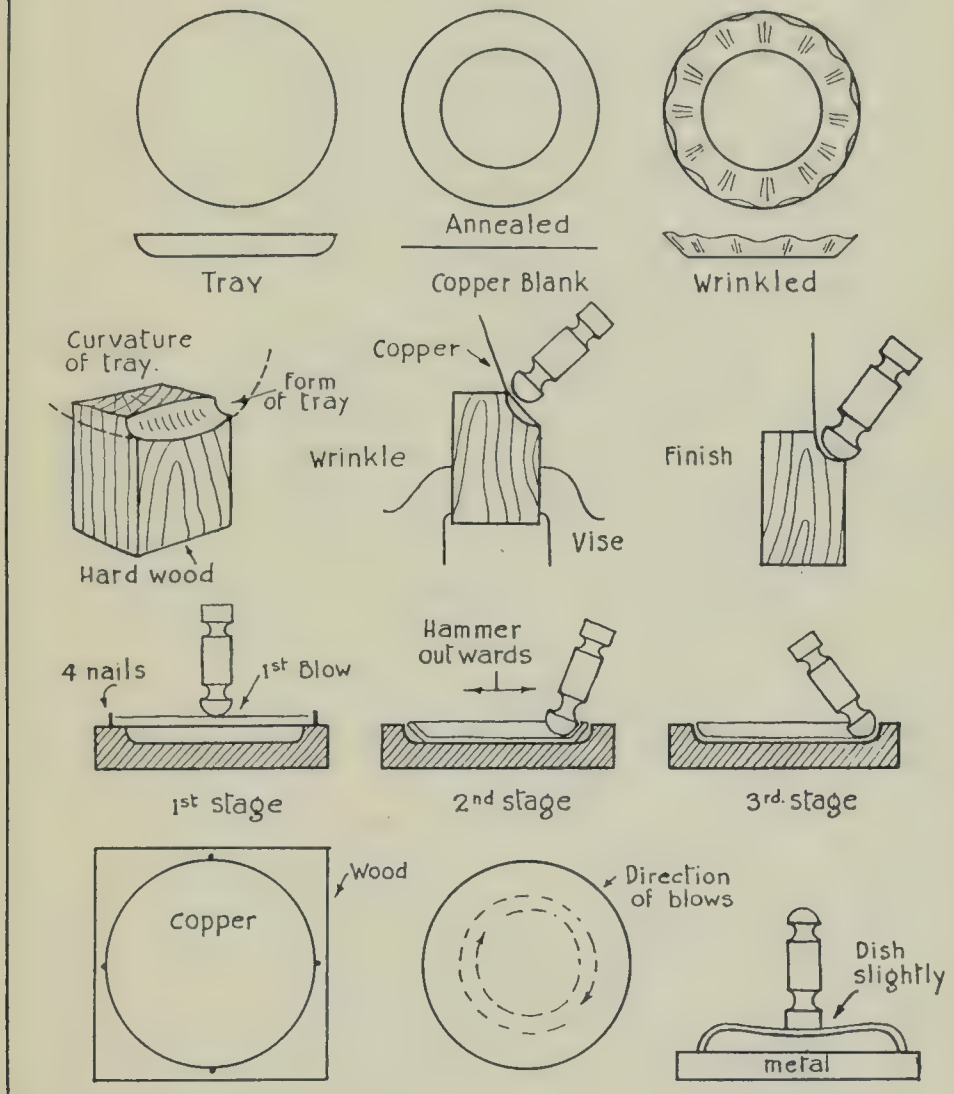
(D)



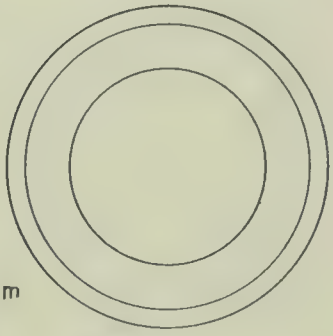
(E)


Appropriate ornament on flat and curved surfaces
Sections
E
F.
G
H
I
Rule :- The main lines of the decoration on a curved surface should be similar to the shape of the section.

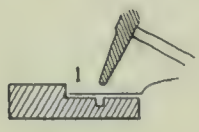
REPOUSSE METAL WORK

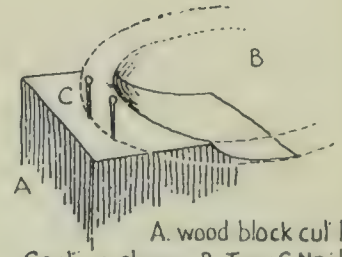


REPOUSSE

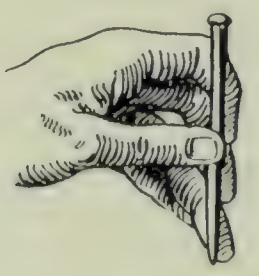


Wired Rim





A. wood block cut to Section shown B. Tray C. Nails to fit edge to



Correct way to hold Tracer

GEOMETRICAL DESIGN.

IT seems strange after giving lessons in design which emphasize the artistic superiority of freehand oval curves over mechanical compass curves that it should be necessary to study mechanical geometrical forms. Yet the advisability of such a step from a decorative standpoint cannot be questioned as there is a geometrical basis for nearly all industrial art. A network of geometrical lines often lies behind the most florid of patterns and the most naturalistic of designs often has behind it a severe construction though it may be almost indetectable.

A geometrical basis assists in establishing order and dignity and prevents much that is unsatisfactory in design. Obedience to law, or liberty under restraint of law, although sounding paradoxical, will assist and not prevent in producing beauty.

Moreover, straight-lined mechanical patterns are, of all designs, the earliest and from such, have all decorative refinements developed. Not only in ornament is this so but also in architecture. From the straight-lined lintel-beam style to the most foliated tracery; from the geometric designs which

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characterize the Norman period to the free scrolls and naturalistic forms of the decorative period of Gothic architecture.

Geometric ornament being the most primitive is therefore a basic style whether it be in continuous bands, enclosed panels or all-over patterns.

The three elemental geometric forms from which designs are made are: (a) the vertical or horizontal straight lines, (b) the inclined line, and (c) the curved line. The harmonizing and balancing of these three forms combine to make a problem worthy of any designer.

In proceeding to evolve harmony from these three separate units it will be found that the junctions of curved lines with curved lines, or curved lines with straight lines should all be tangential; that is all lines should flow from a main stem. Here is a fundamental principle of beauty which when properly understood will assist materially in obtaining satisfactory results. Flowers and other natural objects to be used as ornament should not be copied direct but conventional representations founded upon them, should be designed to suit the tools and material which have to be used in making the decoration. Each type of decoration, be it wood-carving, stained wood, stencilling, gesso, wood-block printing, pen-printing, metal repousse or metal etching, should all have their particular characteristics preserved.

In arranging a series of geometrical lessons one is compelled to commence with some preliminary drill on the correct use of drawing instruments, compasses, set squares and T squares. Otherwise students are sure to contract unfortunate habits which will ultimately retard their progress and from which they will find great difficulty in freeing themselves.

The exercises on page 57 are arranged for this purpose, and will provide excellent practice in drawing horizontal and vertical lines with the T square and set squares. The patterns formed are eminently suited for the veiner or V tool, although it must be admitted that from an artistic point of view they could be improved. It has been previously shown that no design can show complete harmony without the three elemental forms being represented. These are straight lines, (vertical and horizontal), inclined lines, and curved. The borders on page 57 are composed of vertical and horizontal lines, and inclined lines, but there are no curved lines. As interest is increased by the contrast between curved and straight lines, the lack of the former in the border designs must be a distinct loss.

On page 58 will be found exercises for use of compasses. It is necessary that students handle the instruments with ease, and the drawing of circles will prove that while some pupils have an instinct for such work, the greater number have

to be taught by rigorous practice. Page 59 shows some of the conventions used by draughtsmen and these should be adhered to throughout the lessons. If any further information is required students cannot do better than refer to the following work by French and Svenson—Mechanical Drawing for High Schools, published by McGraw, Hill Book Co.

It is also advisable to be conversant with Geometrical Terms. The words and definitions enrich the vocabulary of the student, and thus materially increase his ideas. Without a correct knowledge of geometrical definitions no clear thinking or reasoning about geometrical problems can be indulged in.

PRACTICAL GEOMETRY.

Definitions.

The circle is a figure enclosed by one line called the circumference, every point of which is equally distant from a point within called the centre.

Sometimes the circumference is called the Circle.

An *arc* is any part of the circumference and a straight line joining the ends of an arc is called a *chord*.

A *segment* is the part of a circle enclosed by an arc and its chord.

A *diameter* is a line drawn through the centre and terminated both ways by the circumference.

A *radius* is a straight line from the centre of the circumference to its outside edge.

A *semicircle* is a figure enclosed by a diameter and half the circumference.

A *quadrant* is the figure enclosed by two radii at right angles with each other and a quarter of the circumference.

A *sextant* is the figure enclosed by two radii at an angle of 60° and a sixth part of the circumference.

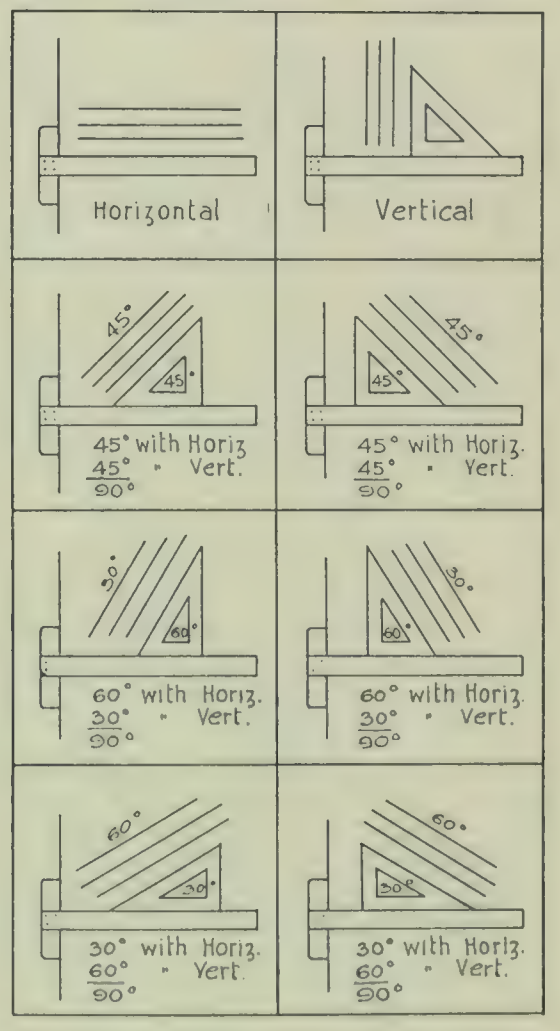
A *sector* is any part of a circle contained by two radii and the arc between them.

Concentric circles have the same centre but different radii.

Eccentric circles have not the same centre; the term is generally used when one circle is within another.

GEOMETRY

OBTAINING ANGLES BY T SQUARE AND SET SQUARES

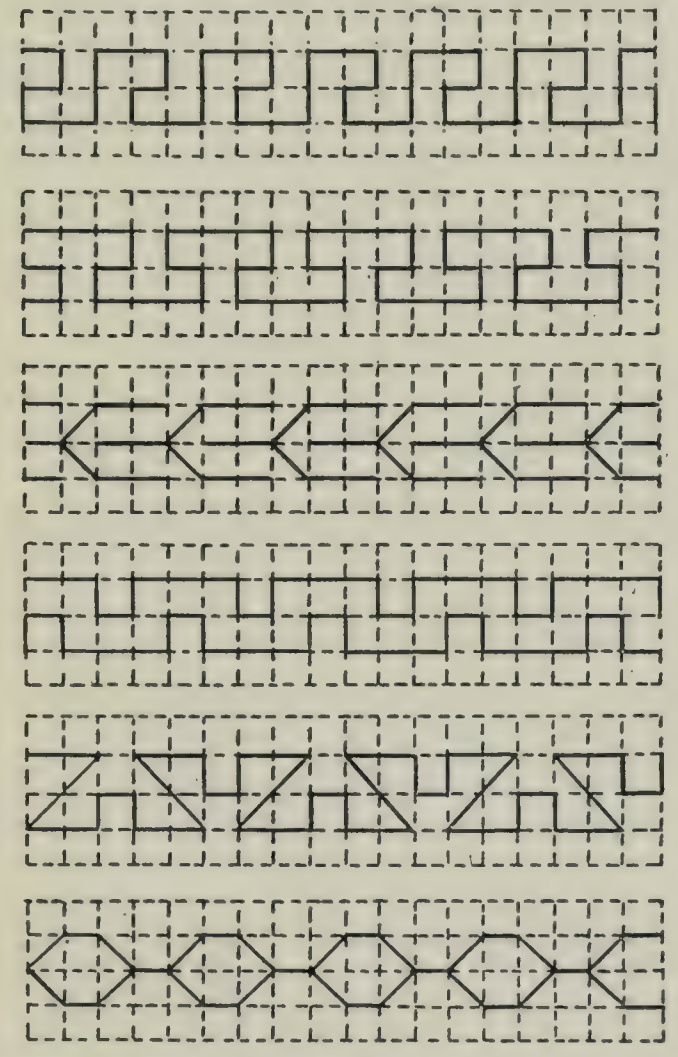


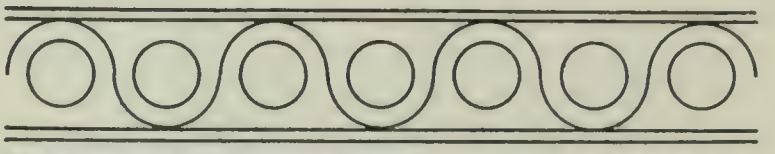
DESIGN FOR INDUSTRIAL ARTS

GEOMETRY. Lesson 1.

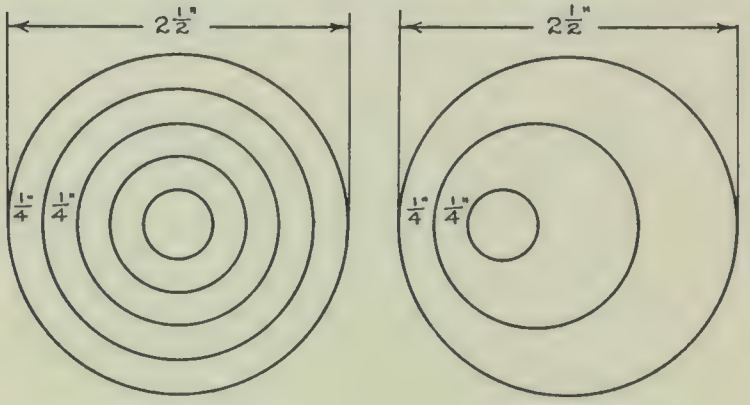
SET-SQUARE EXERCISES.

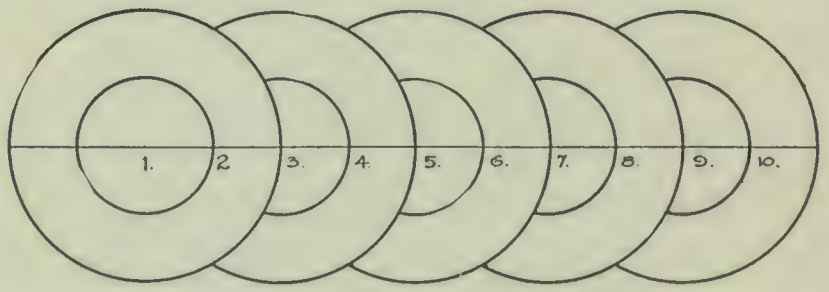
These would make good V Tool Borders.

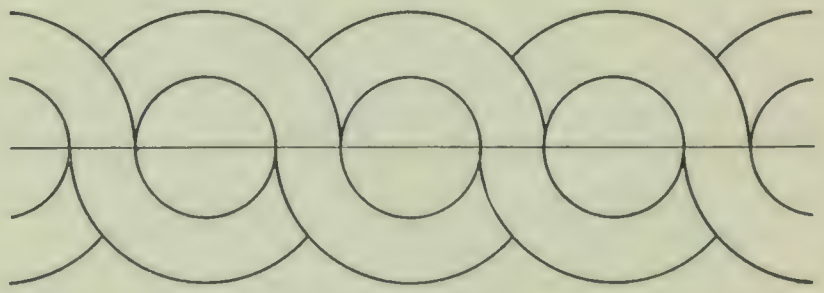




EXERCISES ON THE USE OF COMPASSES

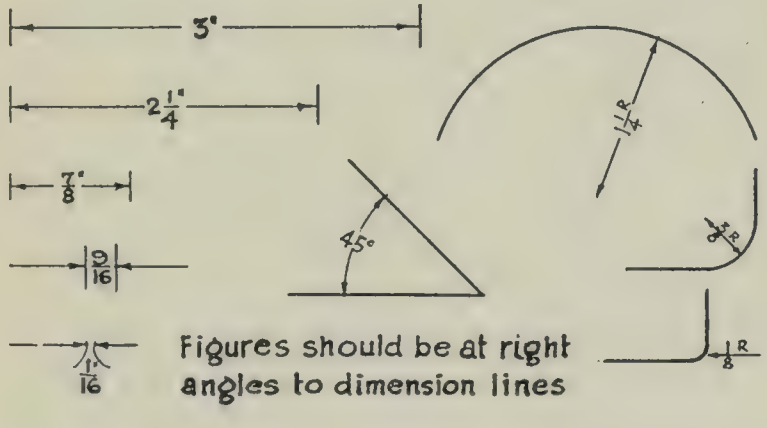




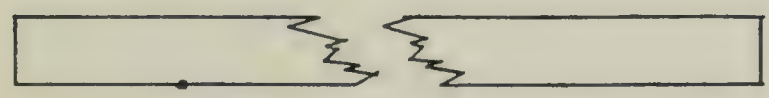


DRAWING CONVENTIONS

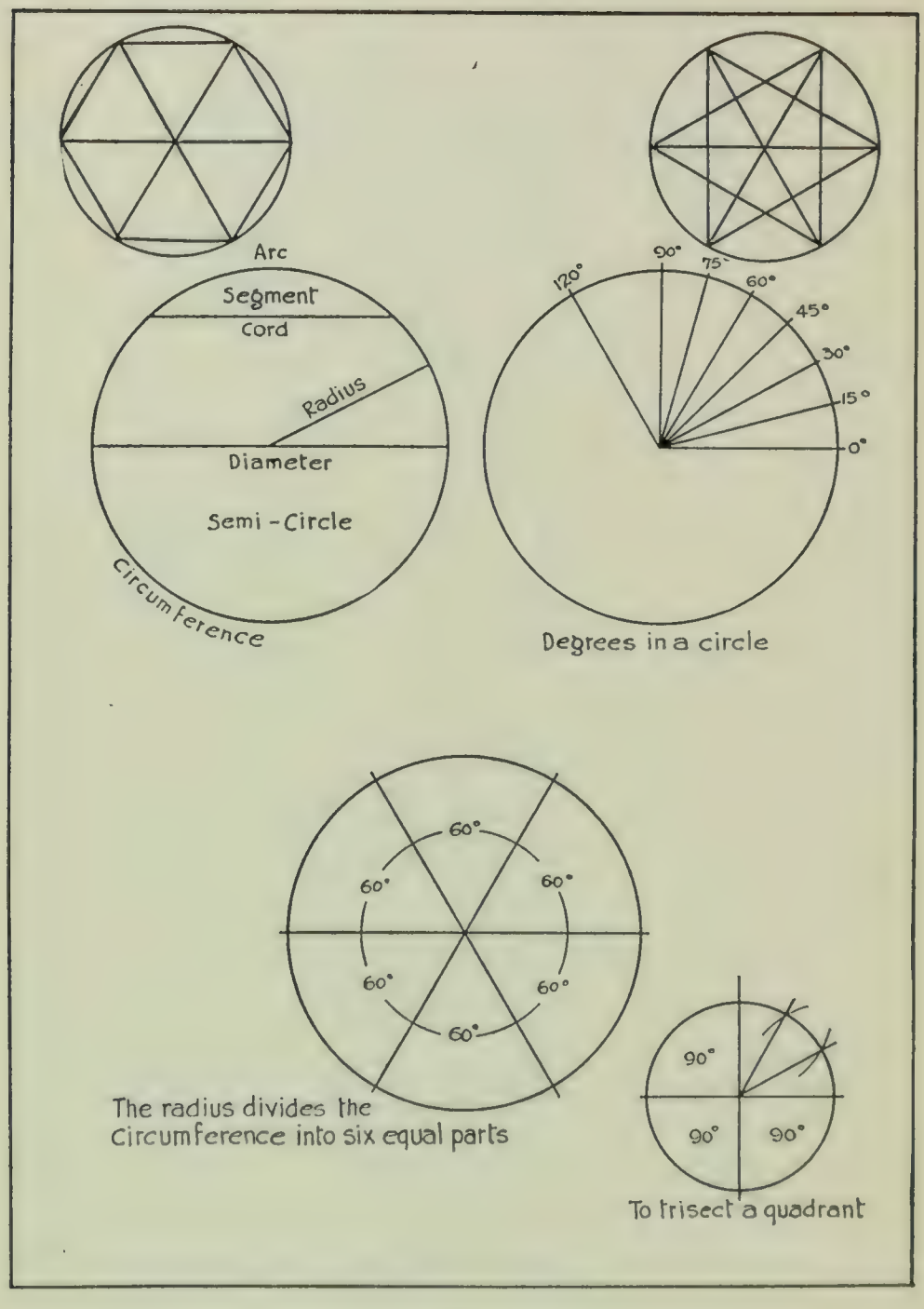
1. Full Line – Visible Outline
2. Full Dash – Invisible Outline
3. Dot and Dash – Center Line
4. Light Line – Dimension
5. Chain Line – Section or Cutting Plane
6. Fine Dash Line – Projections

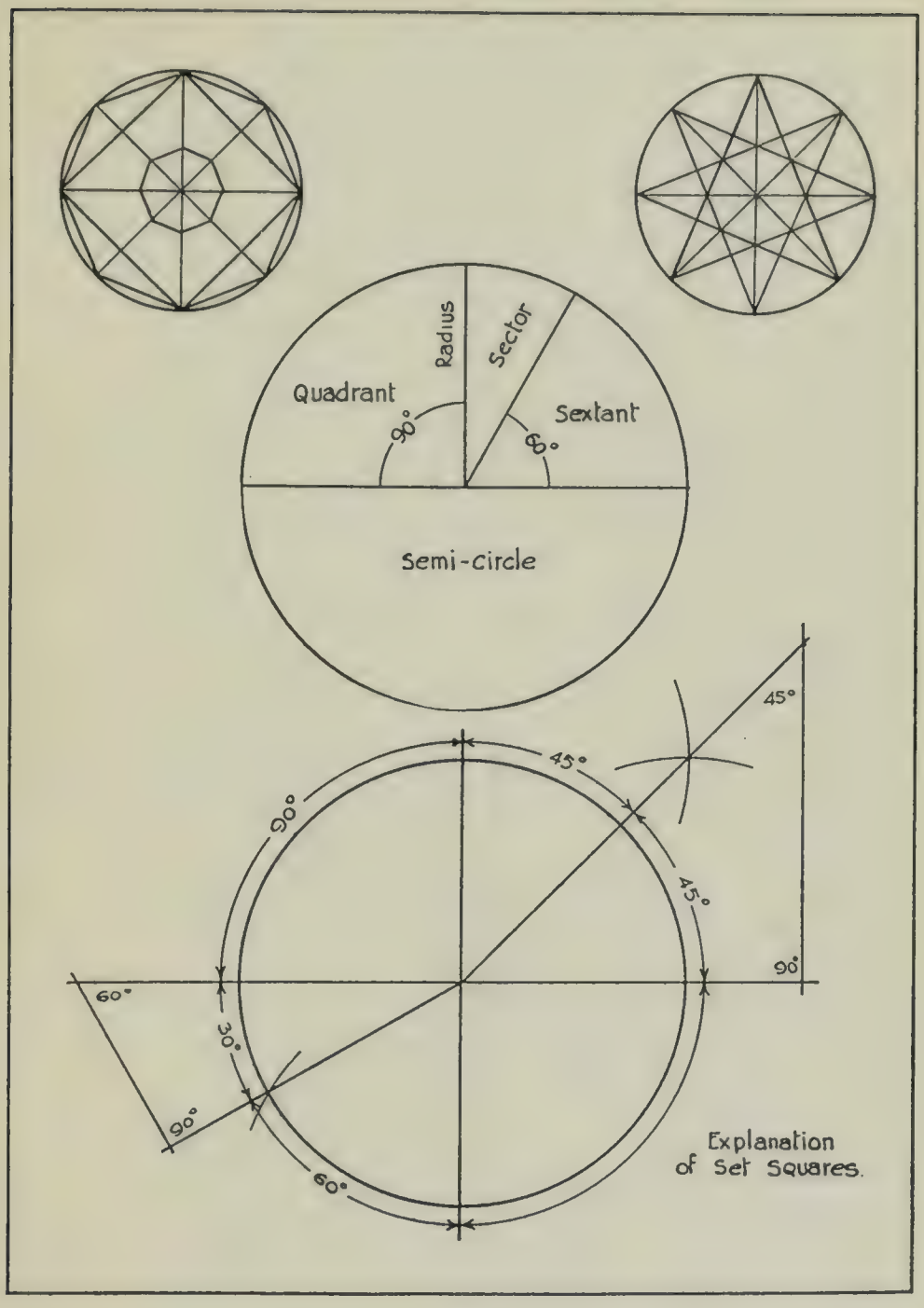


Figures should be at right angles to dimension lines



Broken Material


Arc
Segment
Cord
Radius
Diameter
Semi - Circle
Circumference
120°
90°
75°
60°
45°
30°
15°
0°
Degrees in a circle
60°
60°
60°
60°
60°
60°
The radius divides the
circumference into six equal parts
90°
90°
90°
To trisect a quadrant



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Geometrical Problems.

I. To bisect a given line, that is, to divide it into two equal parts.

With centre A and any radius greater than half the line, describe an arc above and below the line. With centre B and the same radius intersect it at C and D. Draw the line CD.

II. The arc AB is bisected in the same manner.

III. To bisect a given angle A B C.

With centre B and any radius, describe an arc to cut the lines in D and E. With centres D and E and any radius, describe arcs to intersect as at F. Draw the line BF.

Note:—Both the line, arc and angle may be divided into four, eight, or sixteen equal parts by a series of bisections.

IV. To draw a line parallel to a given straight line AB at a given distance CD.

With radius CD and any points EF in the line as centres describe arcs on the same side of AB.

Draw a line to touch these arcs.

V. To draw a perpendicular at the end of a given line AB. Take any point C nearer to A than B.

With centre C and radius CA describe an arc DAE. From the intersection D draw a line through C to meet the arc in E, thus making a semi-circle. Draw AE "The angle in a semi-circle is a right angle". Euclid ii, 31.

VI. To draw a perpendicular from a point C on the line AB. This should be done in a similar manner.

VII. To trisect a semicircle.

Bisect AB in C. With A as centre and AC as radius describe an arc, cutting the semicircle. With B as centre and BC as radius do likewise.

VIII. To construct a hexagon in a circle.

Proceed as in problem VII.

Note:—The dotted lines show an equilateral triangle.

IX. To construct a hexagon with the length of one side, AB given.

With A as centre and AB as radius describe an arc. With B as centre and BA as radius describe an arc, cutting the first one at C. With C as centre and CA as radius, describe a circle touching points A and B. The distance AB will be found to go six times round the circumference. Complete the hexagon.

X. To construct an octagon in a square ABCD. Find the centre of the square E. With A as centre, and AE as radius, describe an arc touching the sides of the square at F and G. Make

similar arcs with centres BC and D. Complete the octagon.

XI. To construct an ellipse by the string method.

An ellipse is a plane figure bounded by one continuous curve described about two points (called the foci) so that the sum of the distances from every point in the curve to the two foci may be always the same. It is frequently but erroneously called an oval.

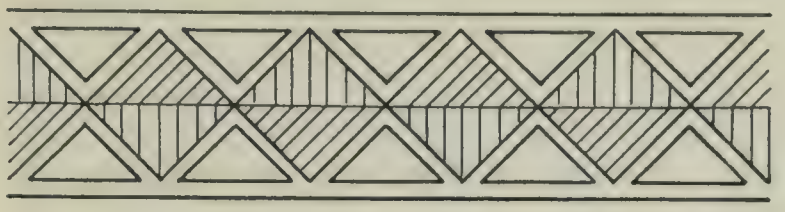
To describe an ellipse, its longest diameter (major axis) AB and its two foci E and G being given.

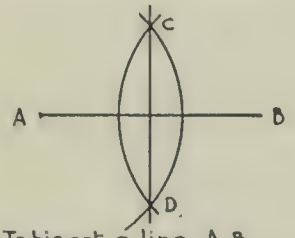
Fasten two pins to a piece of thread or string so that the length of thread between them may be equal to the major axis AB.

Fix one of the pins at E and the other at G. With the point of a pencil draw the thread tight in the form of an angle. Move the pencil round from A to B taking care to keep the thread tight in the form of an angle. Move the pencil round from A to B taking care to keep the thread all the while equally tense. In the same way describe the other half from B to A.

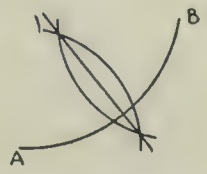
XII. To construct an approximate ellipse with the curves of circles.

Bisect the long diameter AB and obtain C. Bisect AC and CB. Describe two circles touching each other at C. Divide each circle into six parts beginning at A and B. Use the radius as the unit of measurement. Obtain points E and F and complete the ellipse.

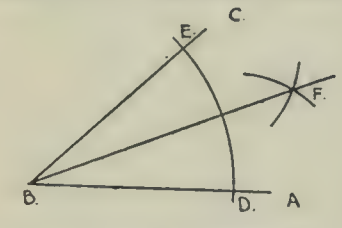




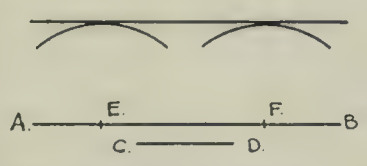
I To bisect a line A.B.



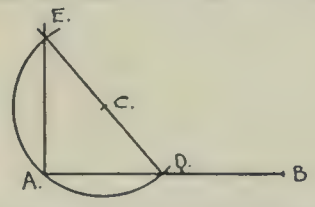
II To bisect an arc A.B.



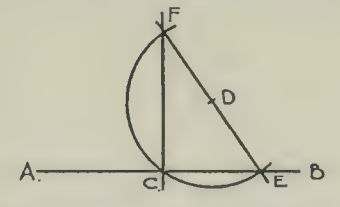
III To bisect an angle A.B.C.



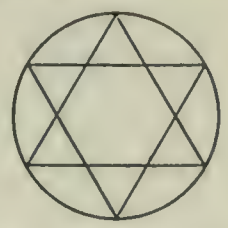
IV To draw a line parallel to a line A.B. at a given distance C.D. from it.

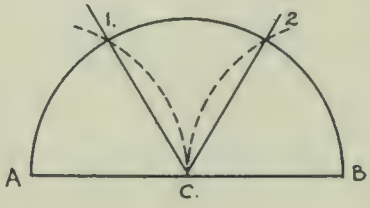


V To draw a perpendicular at the end of a line A.B.

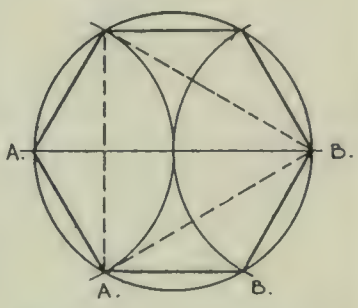


VI To draw a perpendicular from a point on the line A.B.C.

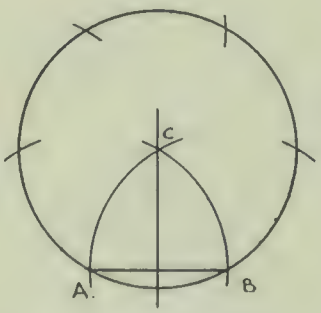




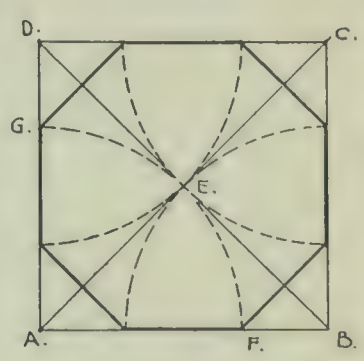
VII To trisect a semicircle



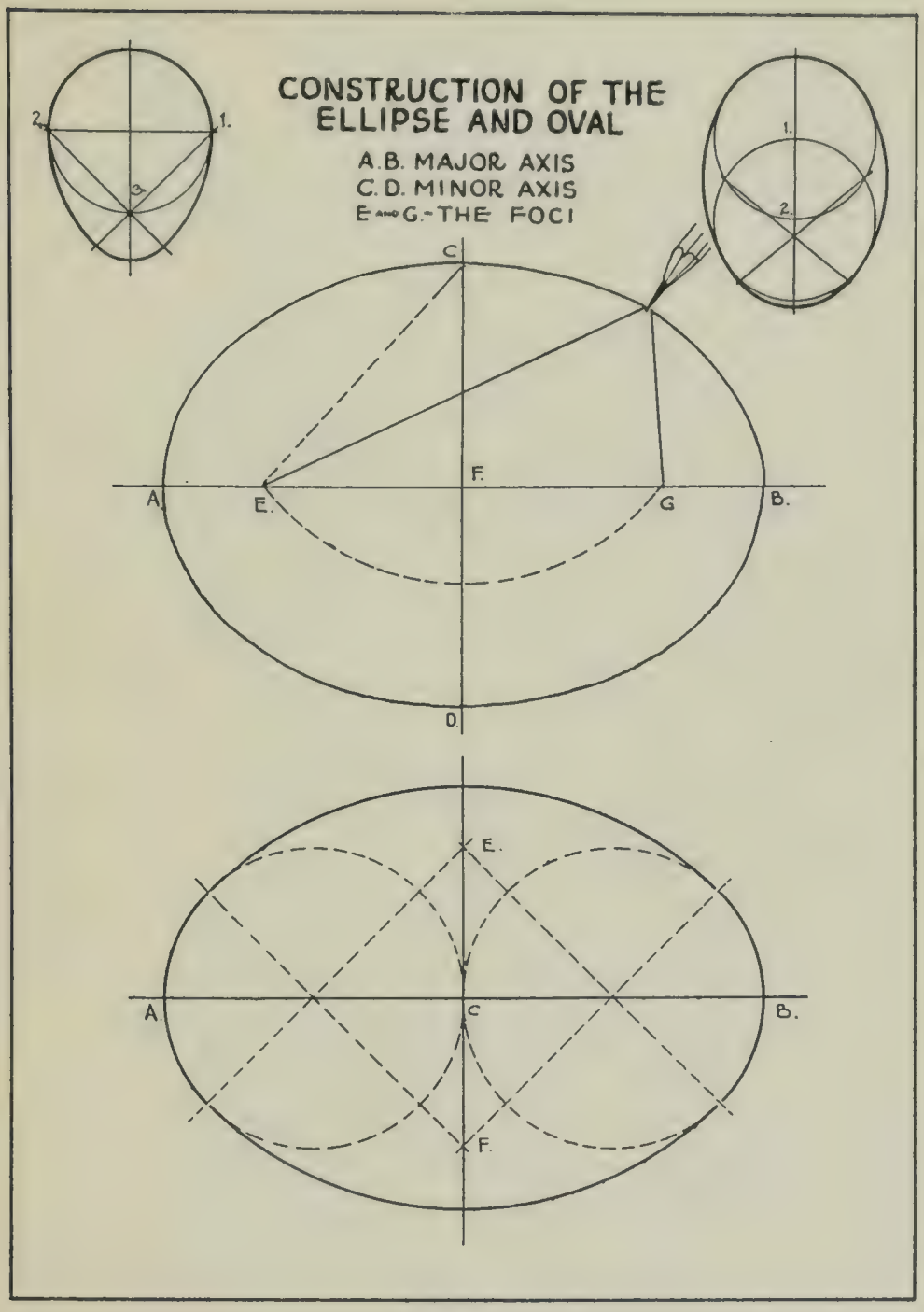
VIII To construct a hexagon in a circle.



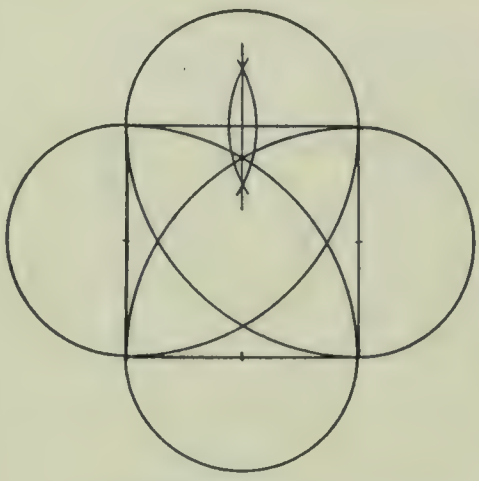
IX To construct a hexagon with the length of one side A.B. given.



X To construct an octagon in a square.

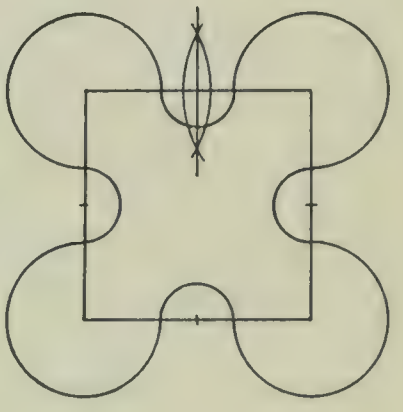

CONSTRUCTION OF THE
ELLIPSE AND OVAL
A.B. MAJOR AXIS
C.D. MINOR AXIS
E and G.-THE FOCI
1.
2.
3.
C
A
E.
F.
G
B.
D
E.
A.
C
B.
F.

GEOMETRY
BASIS OF GEOMETRICAL FORMS



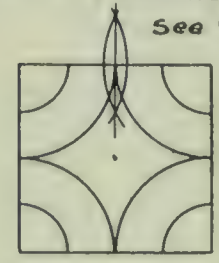
I Construct a square.
Inscribe quadrants in a square
Bisect a line.
Describe a semicircle.

See fig. A.



II Construct a square
Bisect a line.
Describe semicircle

See fig. B.



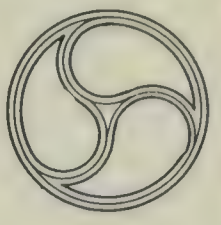
III Describe a square
Bisect a line.
Inscribe quadrants
Find the centre of square

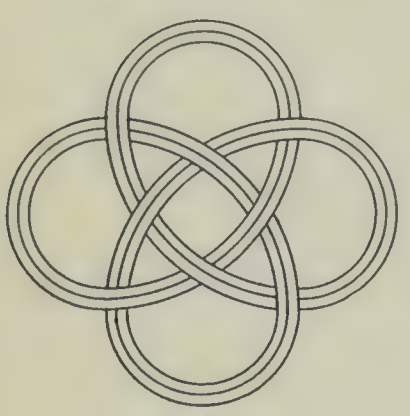
See fig. C.

IV Describe an equilateral.
triangle.
Bisect a line.
Inscribe semicircle.
Find the centre of triangle

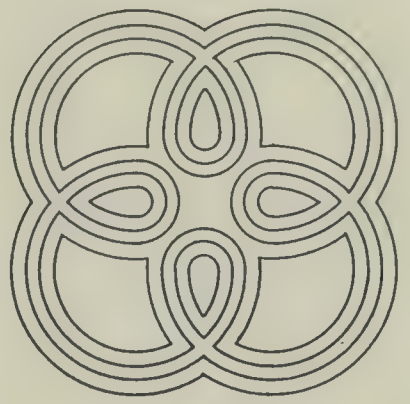
See fig. D.

GEOMETRICAL FORMS



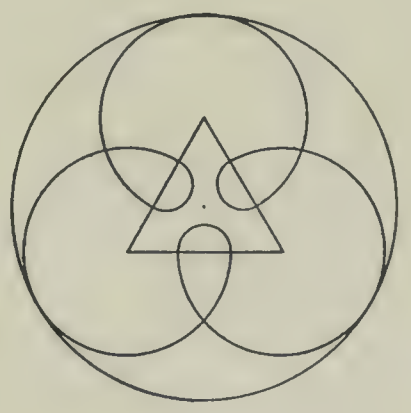


A.



B.

C.



D.

SCALES.

IT is frequently necessary to make the drawings of objects larger or smaller than the objects themselves. The plan of a house, for instance, cannot conveniently be drawn as large as the house itself. It supplies information for all practical purposes, if the drawing preserves the same ratio in its parts as the original does.

To enable one to make a reduced or enlarged drawing a scale is used. Suppose we wish our drawing to be $\frac{1}{12}$ of the size of the original, a distance of 1 foot on the object would be represented by 1 inch on the drawing. On the scale or rule used in this case, the inches would represent feet and if each inch was divided into twelve equal parts each part would represent $\frac{1}{12}$ of a foot, the scale would thus be 1 inch to 1 foot, or $\frac{1}{12}$ of the actual size. CD is a scale of 1 inch to 1 yard, or $\frac{1}{36}$ of the actual size.*

EF shows a scale of $\frac{3}{4}$ of an inch to the foot, to show feet and inches. The construction of this latter problem is as follows: mark off a number of divisions each $\frac{3}{4}$ of an inch of the line EF. Each of these will represent a foot. Divide one of them into twelve equal parts and number them as shown in the figure.

*This is termed the representative fraction of the scale.
When very minute divisions are required a diagonal scale is used.

The representative fraction expresses the actual relation as regards size between the object and the required drawing and is found by dividing the length of the object by the distance this length is to occupy on the paper. The latter distance should be such as will divide the former without a remainder. To arrive at this it is sometimes necessary to suppose the object a little longer or shorter so as to get the required division—there should always be sufficient length of paper to come and go on; thus, suppose a drawing has to be made of a table 3′ 9″ or 45″ long. If the drawing is to be 8″ long increase the 45″ to 48″ then dividing 48″ by 8″ we get 6, or a representative fraction of ⅙ full size for the required drawing.

To construct a scale to represent a given fraction:—Take any unit from a full size measure of inches or centimetres and divide it into the number of parts indicated by the denominator of the representative fraction. Each of these divisions will represent the corresponding unit of the required scale. The drawing of the table is to be ⅙ full size. Draw a line and mark off spaces of 2″ to represent feet because 2″ is one-sixth of one foot. The end space of 2″ is divided into 12 equal parts each of which will represent an inch.

A good book at a moderate price is published by Grant Educational Co., Glasgow:—"A Course in Technical Drawing, Bk. I."—D. Miller.

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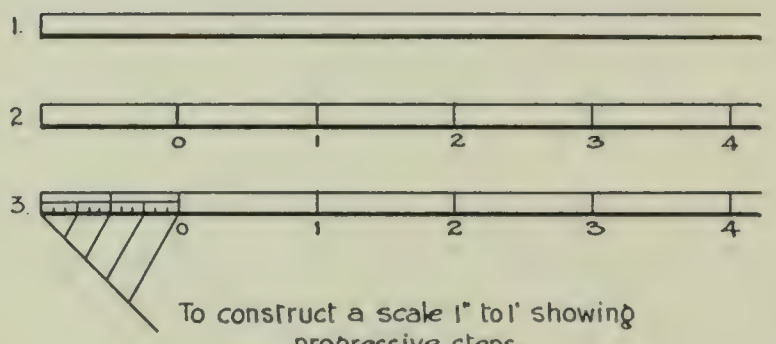
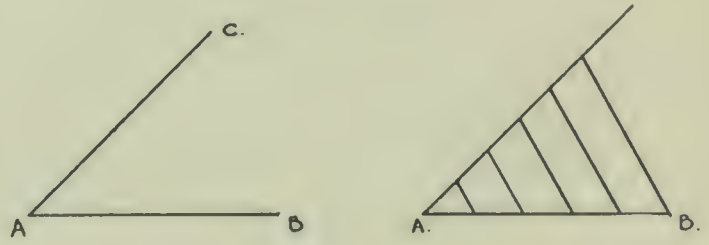
VICTORIA, B. C.

SCALE DRAWING



To construct a scale 1" to 1' showing progressive steps



To divide a line A.B. into equal parts showing progressive steps.